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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES' EQUIPMENT AND SUPPLIES ASSOCIATION.

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Forthcoming Events.

Institute of British Foundrymen.

JUNE 20-23.

Institute of British Foundrymen:—Annual conference in Cardiff.

The Steel Castings Report.

This Report, of which we start publication this week, requires intelligent interpretation, as it may give to the uninitiated a totally wrong impression as to the ability of the British steel founder to supply sound castings. Only last week we spent a pleasant half hour with Sir Robert Hadfield in examining old photographs of large steel castings supplied by his firm many years ago which have withstood the all-important time and service requirements. He has favoured us with his views on the Report which we shall publish when sufficient of its contents have been assimilated by our readers. Throughout the Report no reference has been made to internal chills, cooling spirals or the like, whilst to our mind the provision of clean steel has been insufficiently stressed.

We particularly desire to emphasise that the defects covered by the Report are not peculiar to British practice, and we are informed that a Continental power has been unable to supply itself from its national sources with steel castings demanding the highest performance tests.

Another factor is that the lighter steel castings have apparently given no trouble. If this be so, then an excellent jumping-off point is provided, as experiments should show just where and how defects arise with increasing section and complications. The Report has dealt with attempts to make highly-complicated castings. It has laid bare and classified every defect to which such contraptions are heir. Having done so, it has commented on the natural difficulties, both of a metallurgical character and those to be associated with design, and the economic difficulties. This last phase, interpreted, means that if the buyer demands a high-class casting he must be prepared to pay such a price that the founder can use the best and not necessarily the cheapest method of manufacture, and that out of his profits he can put a little aside for investigational and research purposes. There is, and always will be, ample scope for the exercise of judgment based on experience for the successful manufacture of complicated steel castings. The Report has clearly posed a series of extremely interesting problems for solution, and their solution requires just that type of training which has been propounded by Prof. Andrew for the proposed degree course at the Sheffield University.

Gases and Inclusions.—I.

No subject is being studied by metallurgists with greater concentration and in all countries at the present time than the subject of gases and inclusions in both the non-ferrous metals and in the steels. We can fairly say that this country has led the way, particularly in the work of the committee on the heterogeneity of steel ingots, and much notable work has also been done on the non-ferrous metals. The significance of this matter as applied to cast iron is worth consideration. So far as cast and malleable cast irons are concerned, the quantity and size of the graphite particle is such that it must inevitably overshadow all other inclusions, and, so far as the control of the size and distribution of graphite may be regarded as the control of an inclusion, foundry metallurgists have already done a good deal of work. There are, of course, a number of other inclusions; in particular, the relatively neutral manganese sulphide, and, under certain circumstances, iron sulphide and possibly double sulphides. The phosphides present in the main as the phosphide eutectic can scarcely be regarded as an inclusion, but rather as an inherent part of the metal, but they are also to some extent controllable in distribution and in quantity, and hence may be for the present purpose regarded as inclusions. Other less desired inclusions are particles of slag, oxide, sand, etc.

The question of gas is very closely related to that of inclusions, and the latter term is used rather loosely, frequently without any very clear understanding of its application. Gas may be, and generally is, present in metal in at least three forms. It may be present in the form of gas as such in a simple blow-hole or cavity, and may consist of more or less all mixtures of the oxides of carbon, that is, carbon monoxide or carbon dioxide, hydrogen, nitrogen, or water vapour, which, of course, under certain conditions, may form steam. Oxygen may be omitted here, because it is difficult to believe that under ordinary circumstances oxygen can exist in cast iron in the free state, as there are so many easily oxidisable substances present, such as silicon and manganese. The losses of these in the melting process by oxidation are, of course, well known.

Book Review.

Secondary Aluminium, by Dr. R. J. Anderson. Published by Chapman & Hall, 11, Henrietta Street, London, W.C.2. Price 42s.

Dr. Anderson has ably described the essential details in the recovery of aluminium from scrap, an aspect of manufacture which will be of greatest importance in the future owing to the widely extending uses of this metal. The last chapter, which deals with the economic features, gives the keynote to the present position so far as manufacturing tendencies are concerned. The remelting of scrap to form raw material for further fabrication is undertaken in order to make available a cheaper yet reliable source of aluminium in competition with primary metal. The maker of the finished article has thus got to draw his raw material from either the primary or secondary producers, who are at an obvious advantage when entering the finishing market. There is thus a tendency for the ultimate fabricator to use more scrap and get the direct advantage. To such this book will be of considerable advantage, while also being of direct value to all interested in the re-melting of aluminium scrap.

The re-working of used aluminium is such an obvious economic advantage that its justification is hardly required, but so many prejudices have been raised that this clear exposition of its possibilities is a welcome addition to our literature. Metal scrap of any type is generally looked upon with a certain amount of suspicion, and rightly so. Scrap may, however, be sorted out into grades which can be used with a high degree of certainty, for re-melting with virgin metal or by itself to give satisfactory material.

The first six chapters deal with the various aspects of buying, selling and assorting scrap. In addition to laying down well-recognised principles in regard to this, it gives a clear account of the practical aspects which require special supervision. More care is called for from the scrap dealer, but even then extensive control is necessary in the re-melter's plant.

Chapters VII and VIII deal with the oxidation and fluxing of aluminium, and are the most interesting to a student of the subject. The fact that aluminium has a great affinity for oxygen in preference to other metals makes this metallurgical aspect one of the most interesting, if one of the most difficult to solve. It is emphasised that our knowledge of fluxing is not in an advanced state, and it is not surprising to find that a large number of patented and hush-hush salts are in use, some of which may, and some may not, have any particular value. There is no doubt but that fluxing has not received the attention it has deserved, and this chapter is to be recommended as giving many fundamental ideas on the subject.

Chapters IX to XIII deal with the works practice in the treatment of scrap. While acknowledging the advantages of slow drying out of refractory, it is surely too long to suggest that one or two months are necessary for large furnaces.

The necessity of technical control is strongly advocated and we sympathise with this, especially in dealing with a metal such as aluminium, where all the ordinary experience in other branches of metallurgy is at a discount. It is not that the fundamental laws are different, but rather that the customary methods of getting rid of impurities by oxidation do not give such a wide scope in the case of aluminium. The remaining chapters are concerned with the production of aluminium alloys, recovery and disposal of by-products, quality and uses of secondary aluminium, and an outline of the principles of costing.

Dr. Anderson's book is to be recommended to all who are interested in the manufacture of aluminium. He points out the many ramifica-

(*Concluded in next column.*)

District Presidents.—No. 15.

Mr. H. E. Cookson, who was elected President of the Staffordshire Iron and Steel Institute at the annual meeting on May 15, is managing director of Messrs. C. Akrill & Company, Limited, roll specialists, of West Bromwich. Mr. Cookson was educated at Wolverly School, received his early metallurgical training under Mr. J. Lones, and commenced work with Messrs. Akrills in 1911 as a chemist. He has been successively assistant general manager (1919), general manager (1926) and managing director

Mr. H. E. Cookson.

(1929). He is a member of the Iron and Steel Institute and of the British Cast Iron Research Association, and has been a member of the Staffordshire Iron and Steel Institute for 20 years. Mr. Cookson was gazetted to the 7th Battalion, Worcester Regiment, in 1911, and served with this battalion in the war.

Internal-Combustion-Engine Valve Seatings.

Mr. C. C. Hodgson, in a Paper read before the Iron and Steel Institute, stated that mack-alloy was extensively used in the United States, especially for valve seatings. The composition is:—C, 0.7 per cent.; Si, 0.5 per cent.; Ni, 0.2 per cent.; Cr, 33.0 per cent.; W, 4.4 per cent.; Fe, 4.5 per cent.; Co, 56.5 per cent.

Book Review.

(*Concluded from previous column.*)

tions and difficulties in the use of secondary aluminium, while at the same time giving a clear account of its possibilities. Like the majority of industries to-day it is suffering from the effects of severe competition, but the excellent way in which the various points are put forward by Dr. Anderson should help those interested to establish their practice on a sound basis. The book is well illustrated, and the extensive bibliography at the end of each chapter is a feature which could be more widely adopted with advantage in technical literature. The index is extensive and the book well printed on good paper.

P. M. M.

Random Shots.

In view of the tremendous interest which has been shown by the foundry industry in Marksman's Glossary of Foundry Terms, and the tributes which he has received from all parts of the world (Sunbury-on-Thames and Belgrave Square not excepted), he feels that a few more extracts from the Glossary should be reproduced in this column for the benefit of readers unable to avail themselves of the startling offer he made a month ago.

* * *

Analysis.—A means of discovering what was wrong with that special mixture you used for the urgent job which has turned out a waster.

Carburising.—An item included in the travelling expenses of foundry salesmen.

Case-Hardening.—The process which foundry buyers gradually undergo.

Riser.—Lazy workman suddenly spotted by the foreman.

Core Maker.—Schoolboy in an orchard.

* * *

Chilled Roll.—See Refrigerator.

Parting Powder.—What the wife may detect on her husband's jacket after his return from the dance.

Clay Wash.—New innovation in the foundry beauty parlour.

Vent.—What the foreman often wants for his feelings.

Blown Casting.—Cause of the foundryman's breathlessness.

* * *

Riddle.—Marksman is rather shaky on this point. See "The Riddle of the Sands," by Erskine Childers, for fuller information.

Pig-Iron.—Even when it's all mine there's still enough to go round. And even when it has been refined it is still pig.

Tumbling Barrels.—Used sometimes in foundries, but much more commonly seen in "The Red Lion."

* * *

Marksman, at a meeting of welders recently, overheard one welder remark to another: "Automatic! Automatic! Everything's becoming automatic! In ten years' time burglars will be about the only welding people who haven't got automatic equipment."

* * *

A number of American women tourists were resting in a Fleet Street café after a strenuous bout of sight-seeing, when a highly attractive young woman burst in, obviously greatly excited by some recent experience.

"Say!" she cried. "I've just come from the Chesheer Cheese. An' I saw the cutest old table in a corner where Samuel Boswell used to sit and argue with Amy Johnson."

* * *

Two Yorkshiremen in the railway carriage eyed one another steadily for some time. At last one blurted out: "What's tha' staring at?"

The other replied: "Thee, bai gum—tha art ugly!"

Slightly incensed, the other replied: "Ah knaw ah'm ugly. But Ah ca'ant do anythin' about it!"

To this the first one replied, sadly and thoughtfully: "Oh, yes, tha can—tha can stop at whoam!"

Marksman.

First Report of the Steel Castings Research Committee.*

By a Committee of the Iron and Steel Industrial Research Council.

[*Abstract.*]

Preface.

Inquiries instituted in 1925 by the Engineering Research Board of the Department of Scientific and Industrial Research led to an investigation on steel castings being undertaken with funds provided by that Department. The research was instituted "with the object of improving the quality of steel castings, with especial reference to such defects as blowholes, porosity, flaws, cracks, pits and non-metallic inclusions." The work was begun in the Research Department, Woolwich, in 1927, and prominence was given to the Service aspects, in particular to Admiralty requirements. In some cases, these requirements made severe demands on steel foundries, owing to a necessary combination of intricacy of design and exacting conditions of use of castings which were required to be as light as possible. As the work progressed more attention was given to the industrial aspects, and the investigation became a general research into the improvement of steel castings from the point of view of both manufacturer and user. Up to the present steel castings of medium size have been considered, no work having been done on very heavy or very light classes of steel casting. It is probable, however, that the conclusions reached may apply to castings throughout a wide range of size.

In the early stages of the work a considerable number of castings were obtained, through the good offices of the Engineer-in-Chief, Admiralty, for examination in the Research Department, Woolwich, together with details of manufacture and testing, and records of the effect of modification of moulding and casting procedure, etc. On the basis of this material a survey was undertaken of the most commonly occurring and most dangerous defects to which steel castings in current supply were liable.

From the first it was recognised that the advice and assistance of those engaged in the industry would be essential for constructive progress in the investigation. An invitation was therefore extended to Messrs. W. J. Dawson, J. H. S. Dickenson, A. P. Hague, Dr. W. H. Hatfield and Mr. T. M. Service to act as an unofficial advisory committee, under the chairmanship of Dr. H. Moore, for the purpose of assisting the Research Department, Woolwich, to carry out the investigation on suitable lines. All these gentlemen consented to join the Committee, and the first meeting was held on April 20, 1928. With their generous co-operation a programme of investigation, involving the manufacture, under experimentally varied conditions, and subsequent examination, of 16 castings of a selected design, was drawn up and completed under the direction of the Committee.

As the work proceeded it became evident that this Committee should undertake complete control of, and responsibility for, the work, and accordingly in October, 1930, the Metallurgy Research Board of the Department of Scientific and Industrial Research delegated the future control of the work to the following Committee:—

Dr. H. Moore (Chairman) (Director of Metallurgical Research, Research Department, Woolwich, and member of the Metallurgy Research Board).

Mr. W. J. Dawson (Messrs. Hadfields, Limited).

Mr. J. H. S. Dickenson (The English Steel Corporation).

Dr. R. H. Greaves (Research Department, Woolwich).

Mr. A. P. Hague (formerly of Messrs. Cammell, Laird & Company, Limited).

Dr. W. H. Hatfield (The Brown-Firth Research Laboratories).

Mr. T. M. Service (Messrs. Wm. Beardmore & Company, Limited).

The following Report is the first report of the above Committee. The laboratory investigations were carried out in the Research Department, Woolwich. Considerable use was made of the facilities for radiological examination which exist there, and the Committee desires to record its appreciation of the assistance given in the investigation by Mr. V. E. Pullin, O.B.E., Director of Radiological Research, and his staff. The metallurgical investigations were carried out under the direction of Dr. R. H. Greaves, assisted mainly by Mr. G. F. Gillott, B.Met., and Mr. V. T. S. Foster, B.Met., while Mr. H. Wrighton, B.Met., was responsible for the photographic and photomicrographic work.

Synopsis.

The production of serviceable steel castings demands a sufficient freedom from discontinuities and other defects to render the necessary properties available throughout the casting. A higher standard of quality than that required for ordinary commercial castings is demanded for a small proportion of the steel castings made, namely, the highly-stressed castings, a type which has been kept in view during the progress of the work here described.

In the first part of this Report, the varieties of defects encountered in steel castings are discussed and their influence is considered with special reference to the results of the examination of some typical castings varying from about 1¼ cwt. to 4 tons in weight made in the course of ordinary manufacture. In this way light was thrown on the characteristics and relative importance of defects such as blowholes, shrinkage cavities and cracks, especially "hot cracks" often called "pulls," etc., formed at temperatures little below the freezing point of the steel.

To add to the knowledge of the causes and remedies of the main types of defects, 16 castings of medium size (weighing about 2½ cwts.) were made to the same design under various conditions, each variable being defined as fully as possible. Evidence was obtained of the importance of the correct choice of the position of the casting in the mould (vertical or horizontal) and of the runner; and the effect of variations in the weight, area and spacing of the heads, in the rate of filling the mould and in casting temperature was determined. The conclusions drawn from these experiments apply primarily to the casting under consideration (and in some particulars to this design of casting only) but they also have a more general application.

On the results of this work has been based a discussion of the main difficulties confronting the founder in the manufacture of steel castings, namely:—(1) Natural difficulties, depending on the physical properties of fluid and solid steel; (2) difficulties associated with design, and (3) economic difficulties. When the essential requirements under these three headings are recognised, the way is cleared for the more quantitative application of scientific principles to the manufacture of castings, but even when the fullest physical data are available, every essentially new design of casting remains in some degree an individual problem, and an element of judgment continues to be indispensable.

First Report.

Steel castings are commonly used in the engineering industries in circumstances in which, owing to the form of the structural component in relation to its size, the use of steel in the worked condition (forged, stamped or rolled) would be difficult, inconvenient or unduly expensive. Steel castings are not at present designed to carry stresses so high as those frequently imposed on worked steel; and low- or medium-carbon steel, with a simple annealing treatment, readily gives the mechanical properties commonly demanded. British Standard Specifications for steel castings for marine purposes (No. 30) and for railway rolling stock (No. 24, part 4) are typical as regards mechanical tests laid down, the minimum tensile strengths ranging from 26 to 40 tons per sq. in., and the minimum elongation from 10 to 20 per cent. The difficulties occurring in the production of serviceable steel castings do not lie in securing the mechanical properties demanded, but in ensuring freedom from cavities and other discontinuities to render the necessary properties actually available throughout the casting.

It is often impossible entirely to avoid these defects, but commercial castings are not necessarily unserviceable on that account. A sufficient freedom, and not absolute immunity, from defects is all that is required. Thus, most castings are quite good enough for the purpose for which they are intended, though there is some demand for castings of greater soundness. Out of a very large tonnage of steel castings made, the highly-stressed castings form only a small proportion. For these particular products a higher standard of quality is demanded, a standard which sometimes approximates to that expected in forged steel. Many factors, however, militate against the attainment of such a standard, though the adverse effect of some of them can be mitigated by measures which increase the cost of production. A design taking fully into account the process of solidification of the steel in the mould, with due allowances for the contraction which occurs and with generous provision for feeding heads, becomes more important in this class of casting, which has been the type in view in the present research.

In embarking on a programme of investigation with the object of contributing towards the improvement of steel castings, it was first considered necessary to make a survey of the most commonly occurring and the most dangerous defects to which steel castings in current supply were liable. In this connection the experience and assistance of the Engineer-in-Chief's Department of the Admiralty were of the highest value. The Admiralty's experience as purchasers of steel castings was summarised, at a Conference held in Glasgow in 1928, by Engineer-Commander J. B. Sedgwick, R.N., in a Paper on steel castings from the engineer's point of view.[1] After referring to the engineering requirements of several types of casting, such as those required to withstand the action of superheated steam, possibly at 700 deg. F. (370 deg. C.) and at high pressure, and to various machinery castings, such as bed-plates and engine columns, Commander Sedgwick detailed the general character of defects which had resulted in the rejection of steel castings made to Admiralty specifications as blowholes, draws (generally at flanges or changes of section), porosity under pressure tests, contraction cracks, sand inclusions, scabbing and failure in mechanical tests. The number of failures in mechanical tests, he stated, was comparatively small, and nearly all the troubles were due either to draws or blowholes or porosity of some sort or other. The evidence for these defects was based on visual examination of the surface of the castings and on mechanical and

* Published through the Iron and Steel Institute.

1 Proceedings of the Institute of British Foundrymen, 1928-29, Vol. 22, p. 591; FOUNDRY TRADE JOURNAL, 1928, Vol. 39, page 357.

XUM

pressure testing. It will be seen later that under the term "blowholes" Commander Sedgwick included cavities which would not be regarded as blowholes by steel metallurgists.

At the Glasgow Conference prominence was given to the results of radiological examination of steel castings. A Paper contributed by V. E. Pullin[2] gave a brief description of the technique of X-ray examination and outlined its possibilities. Diagnosis of the defects in steel castings by superficial examination is not satisfactory. The long-standing practice of breaking up an occasional casting and examining the fracture for defects gives useful information, but recent developments of radiology enable greater knowledge to be obtained without the necessity of destroying the casting.

Critical Examination of Castings in Current Supply.

For the purpose of forming an opinion as to the most serious defects met with in steel castings, a considerable amount of laboratory work has been carried out on steel castings in current supply. This involved radiological and metallurgical examination. Some remarks on the interpretation of radiographs are contained in the appendix on "The detection of faults in steel castings by radiological examination." The methods used in the metallurgical examination have been described in a Paper by G. F. Gillott on "The critical examination of steel castings."[3] They comprised:—(1) Sectioning for comparison with radiographs to obtain direct evidence of the form, dimensions and metallurgical character of the features corresponding to the peculiarities seen in the radiographs; (2) chemical analysis; (3) macroscopical examination; (*a*) sulphur prints; (*b*) macro-etching with suitable reagents, such as nitric acid, Heyn's reagent or Humfrey's reagent, followed by ink printing of sections; (4) microscopical examination of selected regions after ordinary etching and after etching with reagents for detecting segregation, distribution of phosphorus, etc.; and (5) mechanical testing: tensile, bending, hardness and notched-bar impact tests in selected regions.

The detailed examination of about 15 castings in current supply from different sources and varying from about 1½ cwt. to 4 tons in weight, coupled with a more general examination of at least double that number, has led to the view that contraction cavities and cracks of various types are the defects which are more widespread, dangerous and difficult to overcome than any other commonly occurring defect in steel castings. Blowholes may also be troublesome and render a casting unserviceable, but they may readily be prevented or controlled by recognised methods. These three main types of defect are considered in detail below.

Blowholes.

There is a tendency to classify under this heading all cavities in a casting from whatsoever cause they arise, but the term should be restricted to the following two types of voids:—

(*a*) Those due to gases derived from the steel. These are small cavities, usually with bright surfaces, spherical in shape or ellipsoidal with the longer axis at right angles to the surface of the casting. They may be situated in any part of the casting and may penetrate rather more deeply into the wall at the top than at the bottom of a casting. In some cases the blowholes are confined to regions, 0.1 to 0.5 in. deep, below the skin and (unlike contraction cavities) they may be more plentiful in thin than in thick sections. At the same time, the feeder heads may have functioned properly and there may be complete absence of piping and of shrinkage cavities. The occurrence of blowholes in the casting points to imperfectly deoxidised steel, and provided that well-made steel is employed, blowholes due to gas derived from the steel are of comparatively rare occurrence.

(*b*) Those due to gases derived from the mould. Local occurrence of blowholes at one end of a casting or at one position generally points to entrapped gases (air or steam) derived from the mould as the cause. A possible cause of such blowholes is inadequate venting of the mould or core. The cavities are spherical or elongated and present an oxidised surface. The adjacent steel is decarburised, only to a very slight depth if the cavities are due to entrapment of air, but often to a considerable depth when they are caused by steam derived from the mould. They are frequently associated with shrinkage cavities, and large cavities with an oxidised surface and an envelope of decarburised material are due to the combined effect of shrinkage and of gases from the mould.

A ring of T-section (weighing about 1½ cwt.), cast nearly horizontally in a green-sand mould, showed extensive cavities at the junction of the wall and the internal flange. The distribution of the cavities in the four quadrants of the ring bore some relation to the number and arrangement of the feeder heads. The cavities were not associated with segregation but were marked by extreme decarburisation of the surrounding metal. This decarburisation was much more marked than that at the outside of the casting; the character of the defect suggested that a considerable amount of oxidising gas, probably steam and air, was blown through the liquid metal at the junction of the flange and ring, which being the thickest section, would be the last to solidify. The gases responsible were thus almost certainly derived from the green-sand mould. It seems doubtful whether increased permeability or improved venting could prevent the trapping of upward-rising gas at this position in the mould, and the occurrence of the defect indicates the desirability of using dry-sand moulds for castings having a re-entrant angle on the under surface.

Contraction or Shrinkage Cavities.

These are the most frequently occurring voids; they are caused not by gas but, like piping in ingots, by the natural contraction of the steel when passing from the liquid to the solid, and cold, state. They can only be avoided by adequate feeding of the casting. If they are entirely enclosed within the wall of the casting their inner surfaces are generally bright and frequently show a dendritic growth of crystals. If there is access of air or oxidising gases to the cavity the surfaces may be oxidised. Almost all large cavities in castings are contraction cavities. They are due to inadequate feeding with liquid metal, either owing to insufficient or unsuitably disposed heads and runners or because of some error in design by which thick sections are necessarily fed through thinner walls.

In illustration of these defects the results of examination of a large steam valve may be quoted. A section, which appeared to be quite sound on the outside near the top of the casting in the position as cast, was radiographed, with the result that a chaplet and a large cavity behind it were clearly revealed. On sectioning, the cavity was disclosed. It had remained perfectly bright, and presented a smooth upper surface and a lower surface showing dendrites in relief. Owing to the design of the valve, an internal branch (the valve seat), which on its flange attained a thickness of 1½ in., was necessarily run through walls the thickness of which was only ¾ in., the result being considerable unsoundness in the thicker portions. This cavity also was bright, though the surface of the crack, owing to access of air during cooling and during annealing, was oxidised. This valve provides an example of a design in which it was found impossible, without modification, to achieve soundness. Before success could be attained, the valve wall had to be thickened in order to feed the seat, the excess metal necessary being subsequently machined away.

An interesting feature in the macrostructure of many castings is the presence of V-shaped segregates at various positions. These owe their formation to the movement of molten metal towards that portion of the casting where solidification is first completed. The V-segregates thus indicate the direction of effective feeding, which often proves to have been not from the nearest head or runner. Examples will be given later in which macro-etching, in revealing the direction of flow of metal in the walls of a casting, confirms the necessity of using well-designed and substantial heads, and the view that heavy sections should always be cast at the top of the mould so that they can conveniently be fed with a sinking head.

Cracks.

Cracks may be classified according to whether they are formed when the casting is hot or cold. "Hot cracks" are formed at high temperatures little below the freezing point of the steel, and are due to stress set up in the just solidified steel by the contraction of the casting in the mould. They frequently take an interdendritic path or pass through regions of segregation. It seems desirable to include the defects commonly known as pulls, tears, hot tears, etc., under the general description of "hot cracks." In the work described in later sections, a number of examples of hot cracks have been observed, and their avoidance by the use of brackets and chills has been investigated. The actual cracking of the casting is most likely to occur in those regions which solidify at a later stage than the surrounding metal. The use of chills serves to make the cooling of light and heavy sections of the casting more uniform. By hastening the cooling of the heavier mass of metal, they lessen the tendency of the light sections, which normally solidify first, to contract and draw away from the soft and weak heavier sections. Temporary brackets or fins on the thinner sections bring about a similar result of strengthening the region of the change of section. The dimensions of the chills and brackets in relation to the wall thickness are important, but the most suitable dimensions will vary with the casting temperature, speed of pouring, etc., and are not a constant for a given wall thickness. The neglect of a suitable taper at the ends of chills and brackets may lead to displacement but not to elimination of the defective region.

A casting frequently cannot be kept from cracking unless the cores and portions of the mould are made collapsible, or are broken up as soon as the steel has solidified. A study of these devices rather than an increased use of chills and brackets is most likely to lead to overcoming the difficulty of hot cracks. Measures taken to prevent contraction cavities are also of importance in this connection, since regions inadequately fed are the more liable to crack, and fine elongated interdendritic cavities which can readily pass into cracks may be formed as extensions of the usual contraction cavities.

The porosity shown by leakage under hydraulic test was found to be due to cracks, usually to a system of fine cracks, not so strikingly obvious as the larger cracks and contraction cavities, but clearly visible in a radiograph.

The cracking of a casting after cooling down, or at a relatively late stage in cooling, is analogous to "clinking" in ingots and forgings, and is due to high internal stress. It may cause the loss of an otherwise perfectly good and serviceable casting, but the high concentration of stress causing this type of failure can usually be avoided by precautions in the cooling down and also in the subsequent annealing of the casting. Cracking of this type is rare in careful manufacture of castings, and the defect has not been encountered in the numerous castings examined.

(To be continued.)

[2] Proceedings of the Institute of British Foundrymen, 1928-29, Vol. 22, p. 600; FOUNDRY TRADE JOURNAL, 1928, Vol. 39, pp. 358, 415.

[3] Proceedings of the Institute of British Foundrymen, 1928-29, Vol. 22, p. 426; FOUNDRY TRADE JOURNAL, 1929, Vol. 41, page 38.

The Manufacture of Glass Silk.

Glass silk, as its name implies, is composed of very fine threads of glass which closely resemble silk in appearance. It is sometimes confused with what is commonly known as slag wool. It may, however, be pointed out that there are remarkable differences between the properties of the two materials.

The long silky fibres of the glass silk cling together and take up in course of preparation the ideal formation for locking air cells within their structure. The long fibres prevent it from settling; there is no tendency to form large air pockets; it is chemically neutral and being pure glass, indeed no adulteration is possible without detection, the insulation has the permanence and cleanliness of glass and is at the same time rot-proof. It cannot be attacked by any chemical other than hydrofluoric acid.

Spread into various forms the threads lie closely together with a natural tendency to cling in network formation and as they may be stitched, no foreign binder is required. The value of glass silk as an insulating material has for many years been recognised on the Continent, more particularly perhaps in Germany, where power-driven parallel drums which are placed in pairs and driven through clutches so that the one drum may be winding whilst the other is being stripped. Immediately at the rear of the drums is a patented electric melting furnace, which is provided at its side with a series of small orifices through which the molten glass trickles, the threads being caught up by the operator and attached to the rapidly-revolving drum, the surface of which is kept damp, the result being the glass is wound on the drum in the form of a silk-like thread. After the coils have attained the predetermined size they are cut through and thus formed into strands, in this form they are passed through gas-fired ovens where the strands are thoroughly dried. From the stoves they pass to the fabricating shop where they are made into blankets of the required thickness. They are next cut to width, the three standard widths being 1 ft. 6 in., 2 ft. 3 in. and 3 ft.

Placed between covers of paper, they are then sewn with asbestos thread, the ends are trimmed and the blankets are then ready for a great variety of applications on curved and flat surfaces. Obviously the method of finishing is governed by the duty for which they are intended. Thus, panels which are to be used on surfaces of large or moderate curvature, such as tanks, engine cylinders, etc., are backed with wire netting. Mats for flat surfaces have wire netting on both sides.

Fig. 1.—View in Factory showing Operatives Spreading Glass Silk.

the use of glass in this form has steadily increased until it now holds a commanding position.

The introduction of the manufacture of glass silk into this country is due to the enterprise of Chance Brothers, Limited, who commenced the manufacture at their Firhill Works, Glasgow, towards the end of 1930, after a careful examination of the position in this country and also on the Continent. It was decided to adopt the approved electric process which was introduced and developed in Germany, where it has been in successful operation for some few years. For the rest Chance Brothers have themselves developed a complete technique for making up and application in forms adapted to the practice of British engineers.

Our representative recently had an opportunity of going through the shops which have been erected at Firhill for the mass production of glass silk and its fabrication into various commercial forms. A few notes on a process of manufacture which will be entirely novel to most of our readers will no doubt be interesting, particularly, as is evident from the market which has already been obtained, that the manufacture of glass silk is a valuable addition to our manufacturing industries.

The raw material is scrap glass, of course, of a given quality. What we may perhaps call the spinning shop is equipped with a range of

Mattresses proper are covered with asbestos cloth and stabbed at suitable intervals; such mattresses retain their thickness uniformly, and do not go out of shape or get thick at the corners and thin in the middle. The glass silk is made up in strip form for the application to pipes, the standard widths being 3 in., 4 in. and 6 in. in lengths of approximately 9 ft. In the past it has been common practice to use asbestos rope for insulating small steam pipes on account of the simplicity of the application, but it will be readily understood the application of the glass silk, due to its extra width, is still easier.

In the common form the strips are sent out between a covering of paper which is sewn on. Obviously, such paper will char away with the first-time heating. For ease of application with relatively unskilled labour the strip is useful, and, if under cover, no further finish is actually required, though a protective covering of canvas sewn on adds materially to the appearance of the work. With pipes exposed to weather, the finishing cover must, of course, be waterproof, as with any other insulating material. It may be pointed out that the insulation is guaranteed to withstand temperatures up to 900 deg. Fah.; actually it has withstood under tests temperatures up to 1,100 deg. Fah.

This method of insulation has been applied to a number of North-East Coast drifter boilers, than which there is scarcely a more severe test for insulating material. Glass silk has a high degree of resilience, and thus the accidental knocks to which the insulation is subject in such boiler and engine rooms has practically no effect upon the mechanical permanence of the glass. Glass-silk insulation has also been extensively adopted at a large number of iron and steel works, amongst others at the Glengarnock works of Messrs. Colvilles, Limited.

The material was, of course, primarily introduced for heat insulation; at Firhill works it has, however, been successfully developed for sound insulating purposes, and has proved singularly efficient as a sound deadener between the floors, walls and ceilings of buildings. It has also been fabricated in the form of sheets for battery-insulation purposes. From the foregoing it will be evident that glass silk has taken a permanent place in our industrial activities, and it may well be that the fields of usefulness already developed have not carried us beyond the verge of its ultimate possibilities.

Iron and Steel Manufacturers and the Trade Agreements.

At a meeting of the Executive Committee of the National Federation of Iron and Steel Manufacturers on May 18, at which the trade agreements came under review, and particularly the agreement with Sweden, it was decided to send the following resolution to the President of the Board of Trade :—

"This Committee, being fully representative of the British iron and steel industry, believing that the best method of restoring prosperity to the coal industry is to stimulate the production of British industry generally, deprecates the reduction in import duties in the recent trade agreements on the products of this, the greatest coal-consuming industry. The Committee would point out that, owing to the operation of the most-favoured-nation clause, the concessions made under these agreements are automatically extended to other iron and steel producing countries. The Committee further declares that reductions in the duties imposed on the advice of the Import Duties Advisory Committee, which in many instances have proved insufficient to meet present conditions, cannot fail to handicap seriously the reorganisation of the industry, as reductions in the degree of protection destroy the confidence on which alone such reorganisation can be based."

Sir William Larke, Director of the National Federation of Iron and Steel Manufacturers, when asked to comment on the Swedish Trade Agreement, said that he very much regretted the necessity the Government had felt themselves to be under to reduce the import duties on the products of an important section of the steel industry, since a change in the measure of protection which had been accorded to the industry for its preservation under present conditions, after full inquiry by, and on the advice of, the Import Duties Advisory Committee, destroyed that confidence on which alone the reorganisation of the industry could be achieved and the requisite capital expenditure incurred. He felt that this policy involved a definite setback to the efforts the industry was making, and he hoped that some pronouncement could be made that the industry was not likely in the future to be subject to such variations in policy.

Economic Conditions in Japan.—The Department of Overseas Trade has issued Report No. 541, "Economic Conditions in Japan," by Messrs. G. B. Sansom and D. W. Kermode, H.M. Embassy, Tokyo, dealing with the general economic situation in Japan, foreign trade, transport and communications, treaties and tariffs and trade marks, etc., with annexes relating to conditions in Formosa and Korea. The Report may be obtained from H.M. Stationery Office, Adastral House, Kingsway, London, W.C., price 3s. 6d. net.

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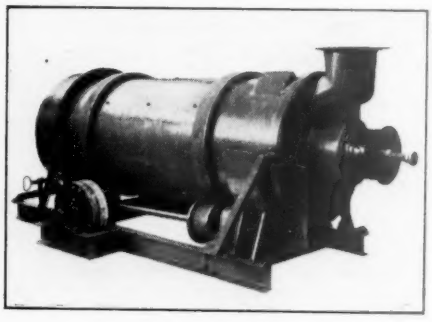
The "Titan" Rotary Oil-Fired Sand Dryer.

This machine has been designed primarily for drying sea sand for foundry use, but is also suitable for dealing with other types of sand. It is built on different lines to the "Titan" coal-fired drier which has been on the market for ten years and given excellent results. The machine is friction-driven, the required power (3 h.p.) being transmitted from the shaft, to which a pulley is fitted, through a pair of pinions to the driving shaft. Fixed on this shaft are two rollers, off which the machined paths fitted to the drum are driven. A pair of idle rollers are fixed at the opposite side of the machine.

The wet sand is fed into the fixed shute by hand or from conveyor or elevator. It is then picked up by a series of scoops attached to the rotating drum or cylinder. The drum is slightly inclined from the feed end to the discharge end. A series of sections are fitted internally on the outer drum and externally on the inner drum. The sand is picked up by the sections, and as the drums revolve a constant stream of sand is falling; this process continues during the passage of the sand from the feed end to the discharge end of the drum. A fixed casing or box marked "C" encloses the discharge end of the drum,



The New "Titan" Rotary Oil-fired Sand Drier.

around which a sieve is fixed. The dried fine sand passes through the sieve and into a shute attached to the bottom of the fixed casing. Sand too coarse to pass through the sieve is discharged over the end of the drum into a shute fixed at the end of casing.

The heat is obtained by means of an oil-burner fitted into a brick-lined combustion chamber carried on the fixed end of the drier. This chamber projects into the rotating centre tube or drum of the drier. The flame passes through the centre tube or drum and is drawn back by natural draft between the centre and outer drums to the chimney.

The standard machine is capable of dealing with 3½ to 4 tons of sand, with a moisture-content of 10 per cent. to 12 per cent., per hour, and takes for this duty approximately 2½ gallons of fuel oil per hour. The machine has been thoroughly tested out in a large foundry producing automobile castings and has proved exceptionally efficient and economical.

Rust-Resisting Steel.—The production of new qualities of steel, possessing increased powers of resistance to rust, has proceeded apace during recent years. One such, that has been successfully applied to various purposes, is "Dalzo" rust-resisting steel, which has unique powers of resisting atmospheric corrosion. It is manufactured by Messrs. Colvilles, Limited. A recent application of interest is seen in the construction of three high-capacity tanks, built of "Dalzo" by Messrs. Mechans, Limited, of Scotstoun, to the order of Messrs. Hendry Brothers, Limited, for the Jamaica Corporation. Each of the tanks is 86 ft. in diameter and 35 ft. 6 in. in height, with capacity of one and a quarter million galls.

Scrap in the Foundry.

By "Onlooker."

Although conditions in the scrap-metal trade have latterly been difficult, owing to the low level reached by copper, spelter and lead, there nevertheless exists a very fair potential demand from consumers for old brass and copper. The use of scrap is almost universal in our non-ferrous metal foundries, but it is in greater demand in some directions than others, and its employment varies with the various classes of work passing through the shops. In the long list of scrap material in common use in this country there are many varieties, a wide and specialised knowledge being necessary for the carrying on of the trade.

During the past year or so imports of scrap from the United States have dwindled in volume owing to exchange difficulties, and, in consequence, there has been a tendency for values to appreciate in relation to virgin metals. Latterly France has been drawing upon our reserves of brass swarf, and a very considerable tonnage has been shipped across the Channel at prices well above anything that foundries here would be prepared to pay, so that one way and another our supplies of old metal are hardly what they were. Fortunately for the trade there are the Government sales at Woolwich and the dockyards, from which sources quite a good tonnage comes on offer, but competition is keen and dealers secure most of this material.

Every foundry manager must regard scrap with a certain amount of suspicion, for in most cases it is a "mixed bag" and may contain impurities of a very undesirable nature. Except in the case of really first-class material, such as process copper, scrap from cable works and the better grades of brass consisting of shell cases, etc., a certain amount of loss from dirt must be expected, and there may be also in the case of alloys some variation in mixtures. Take, for example, extruded metal, now manufactured in such large quantities at the expense of sand castings. Here we get a very wide and ever-increasing range of mixtures, and any foundry introducing such material into heats without making laboratory tests first is running a risk of trouble when the castings are completed.

In America the National Union of Waste Manufacturers has set out a schedule of specifications governing the various classes of brass and copper scrap in common use in that country, but in Britain this course has not been followed. By comparison we have what may be termed an unwritten law governing the quality of old metals, and it says something for the trade as a whole that disputes are of rare occurrence. Buyers naturally make such stipulations as they think fit, and it is up to the seller to decide whether the material he is handling answers the description insisted upon, but with straightforward parcels of a quality recognised by both parties to the deal the summary may be very brief and need not contain special reference to impurities. It is, of course, in the interests of all dealers in scrap to satisfy their customers.

For the most part the foundry prefers to handle scrap which has been graded in accordance with a specification, for otherwise sorting is almost inevitable, and sorting scrap metal calls for special facilities and training. The use of old rolled brass scrap, except of English origin and packed by a reliable house, is inadvisable unless the material is first magnetted to extract tramp iron, which since it is often concealed cannot be detected by sorting over the bench. Swarf should be treated in the same manner, and in parcels of second grade copper wire it is wise to keep a sharp look-out for iron which may usually be detected by the simple expedient of leaving the parcel exposed to a rain shower! As to the proportion of scrap to be used in the charge this must be a matter of decision by the foundry manager.

Officials of the Association Technique de Fonderie.

At the general meeting of the *Association Technique de Fonderie*, held on April 13, the Committee elected the following officials:—

President: Mr. M. H. Magdelenat, managing director of the *Société des Usines de Rosières, Bourges.* Senior Vice-President: Mr. M. J. Lobstein, managing director of the *Fonderies Lobstein, à Colombes (Seine) et Argenteuil (Seine & Oise).* Vice-Presidents: Mr. M. A. Brizon, managing director of the *Fonderies Brizon, à Courbevoie (Seine)*; Mr. M. E. Dady, President of the *Association Amicale et Mutuelle de Fonderie, Paris*; Mr. M. J. Derdinger, Past-President of the *Chambre Syndicale des Fondeurs en Cuivre et Bronze, Paris*; Mr. M. F. Girardet, gear founder, *St.-Die (Vosges)*; Mr. M. Ch. Koehler, managing director of the *Fonderies de St.-Ouen, à Saint-Ouen (Seine)*; Mr. M. L. Montupet, managing director of the *Fonderies Montupet, Paris*; Mr. M. H. Strube, President of

Mr. M. H. Magdelenat
(*Newly-Elected President of the A.T.F.*).

the *Chambre Syndicale des Fondeurs en Cuivre et Bronze*, founder and engineer, *Montrouge (Seine).* Foreign Vice-Presidents:—Belgium: Mr. M. J. Leonard, President of the *Association Technique de Fonderie de Belgique, Grivégnée.* Spain: Mr. M. J. M. Espana, Vice-President of the *Conseil d'Administration des Ets. Bonvillain & Ronceray, Choisy-le-Roi (Seine).* Italy: Mr. M. F. Jarach, President of the *Federazione Nazionale Fascista Del l'Industria Meccanica E Metallurgica, Milan.* Luxemburg: Mr. M. L. Brasseur, engineer, Luxemburg. Secretary: Mr. M. R. Meyer, director and partner of the *Société de Produits Métallurgiques, Paris.* Treasurer: Mr. M. A. Lardin, manager of the *Société Lardin et Cie*, Past-President of the *Association Amicale et Mutuelle de Fonderie, Paris.*

Welding Screens.—When welding is done in a part of a large shop it is usually found that passers-by have an irresistible desire just to glance at the welder. They will often find means of doing so whatever the type of screen provided. One or two firms have found that it is easier to make it possible for this to be done in safety than to take all the necessary precautions to prevent its happening. The means adopted has been to make the top of the screen surrounding the welder's working place of blue glass. It is then possible for passers-by to satisfy their curiosity without danger to their eyes.

Sand-Spun Pipes.

DISCUSSION ON MR. J. B. ALLAN'S PAPER DISCLOSES NEW NOTIONS.

There was considerable discussion on the lecture given by Mr. J. B. Allan, of the Staveley Coal & Iron Company, Limited, on "The Manufacture of Sand-Spun Pipes,"* before the Birmingham, Coventry and West Midlands Branch of the Institute, at the March meeting in Birmingham.

Mr. J. G. Pearce, the Branch-President, introducing the lecturer, said the Staveley Coal & Iron Company had always been well known for its production of pipes in cast iron. The laying down by the company of plant costing some £250,000 for producing pipes by the sand-spun process was one of the most important events in the foundry industry in this country during the last ten years, and was certainly the most enterprising. Mr. Allan had charge of this plant as well as of the foundries of the Staveley Company, and could speak with authority on the subject.

The Raison d'Être.

Mr. Allan explained the nature of the plant at a Glasgow gathering several months ago, so that a brief summary of certain features must now suffice. He said that until 1931 the vertically-cast pipe, cast in pits, held undisputed sway throughout the Staveley Works, and of recent years the output had been approximately 100,000 tons per annum. The earlier practicable methods of centrifugal casting all made use of metal moulds, water cooled or otherwise; and it was not until the development in America of centrifugal casting in sand moulds that the Staveley Company felt satisfied that the correct method had been attained. Their first pipe under the new process was cast in June of 1931. Dealing with the lay-out of the building and the cupola plant, Mr. Allan said the cupolas were of the drop-bottom type and designed for uninterrupted working periods of 24 hours each. This they had proved well able to do.

Moulding Equipment.

Describing the mould-making equipment, he said the flasks for containing the sand moulds were cast-iron cylinders drilled to ensure satisfactory venting and fitted with two steel tyres upon which they ran during the spinning operation. As the complete unit of mould and flask was eventually to be rotated at between 550 to 1,150 r.p.m., a prime necessity was that the mould should be truly concentric with the flask. To ensure this condition, the patterns, for the socket and body respectively, must themselves be truly concentric with each other and with the flask. Accordingly the body pattern was provided with a tapered nose piece, which fitted into a correspondingly tapered hole in the socket pattern, thereby ensuring concentricity between these two parts. Further, the socket pattern was extended beyond the point which was necessary for the actual mould making; and the tapered surface, when in contact with a corresponding surface on the flask, provided the means whereby concentricity was secured at that end of the assembly. The part of the flask which fitted the socket pattern took the form of a bolted ring, and was therefore easily renewable. At the spigot or top end of the flask, when it was in a position for filling, concentricity was obtained by a portable hopper casting. This fitted both the pattern and the outside diameter of an angle flange ring which was fixed to the flask.

The portable casting also acted as a hopper to guide the sand into the flask. The flange served a further purpose, a plate being bolted to it which had a groove on its inner surface into which the sand was rammed. The spigot-end plate when bolted in position closed the mould, and the sand inset ensured that the molten metal never came into contact with any material other than sand. This factor precluded the possibility of chilling at that point. A hole in the middle of the spigot-end plate formed the entrance through which the molten metal was poured.

Core Assembling.

Showing the assembly on the screen, Mr. Allan pointed out the socket core, which was of oil sand, to be seen at the bottom of the flask with its securing plate in position. It would be noticed that the molten metal came into contact with sand only, and that no form of chilling entered into the process. Hence the pipe was a sand casting, just as its cousin, the pit-cast pipe, was. Such qualities as lack of brittleness, ease of cutting and so forth, which engineers had been familiar with for generations—largely conferred by the fact that the bed of the molten metal was sand, its natural one—were all contained in the sand-spun pipe equally with the pit-cast one. The only feature of the manufacturing process of the sand-spun pipe which was common to other centrifugal processes was that centrifugal action entered into all of them to a greater or lesser extent. Actually, however, the sand-spun process was the only one which was wholly dependent on centrifugal action, this being the only means whereby the metal was held against the wall of the mould. It would be realised that in other so-called centrifugal processes which used a chill mould, the metal solidified almost immediately on contact with the mould, and therefore centrifugal effort was of little effect. One great advantage which the sand-spun process possessed over all others was that it was virtually possible to guarantee that any pipe made in this way was free from gas cavities and non-metallic inclusions. The centrifugal effort automatically separated the lighter elements—the non-metallic—from the heavier, and left them on the inner surface of the pipe, whence they were easily removed.

Drying and Casting.

Touching on the methods for making moulds, Mr. Allan said the machines used were Herrman plain jolters; these were made in America and were the only non-British plant in the foundry. After the moulds were completed the flasks were conveyed to the mould-drying station, and these were skin-dried from the spigot end by burners using coke-oven gas. These burners were so designed as to inject large quantities of air through the moulds, in addition to the products of combustion. This arrangement enabled the moulds to be rapidly dried without burning of the blacking. Portable deflectors were used at the socket end to cause the gases to scrub the walls of the moulds at this point. Further gas jets kept the moulds warm and prevented condensation until the socket cores were fitted immediately prior to spinning.

Regarding the spinners, there were seven centrifugal machines, into which the flasks were moved and then removed by hydraulically-operated manipulator gear, which also operated a safety hood enclosing the whole machine while spinning proceeded. Each spinner was provided with its own tilting ladle mounted on a carrier or bogie, which in turn ran on rails on the platform of a weighing machine. Hence, as the iron was poured into the ladle the weight was recorded, and the crane driver operating the ladle merely poured a predetermined quantity equivalent to the weight of the pipe to be cast. The casting ladle being filled, the carrier was run forward into the casting position and a signal lamp automatically indicated this position. Another signal lamp lights when the machine was up to speed, and when the two lights appeared the spinner operator tilted the ladle by means of an hydraulic ram. Even distribution of the metal was completed within a few seconds of pouring, and allowing about one minute of spinning per inch of diameter, solidification should by that time have taken place. As to cooling, on account of control in this direction the percentage of bent pipes was infinitesimal. It was quite usual to run for weeks without seeing one. The spinners were intended to work in pairs, and the inlet and outlet gantries of two machines were adjacent to one another; thus it was normally possible to put down and pick up two flasks at one time by the special 10-ton manipulator cranes.

Cooling and Stripping.

The full flasks were transferred to the cooling gantry, which was of sufficient length to enable each flask to occupy sixty to seventy minutes in traversing it when the plant was running to full capacity. Hence by the time each pipe had reached the stripping station it had lost all colour of heat and could not take harm from exposure. The pipes were stripped from their moulds by means of hydraulic rams. It was found impossible to carry this out direct owing to the locking of the sand, and a preliminary operation was needed which consisted in passing two tubes, from the ends of which compressed air issued, through the sand. The effect of this operation was to remove a longitudinal section of the mould, after which the remainder of the stripping operation was comparatively simple.

In connection with grinding, Mr. Allan stated that slight flashes, or similar surface imperfections, were, if present, generally located at the pipe ends, and were removed by ordinary pneumatic turbo-hand-grinders. Internal grinding for the removal of non-metallic matter was effected by electrically-driven grinders, the wheel of which was mounted at the end of a long shaft. The pipe was rotated on driven roller supports in the opposite direction. They had found it necessary to substitute wet for dry grinding, so that no dust nuisance should arise. The lecturer then dealt with cores and sand-handling plant, devoting some time to a description of sand preparation and manipulation and its reconditioning.

Advantages.

Among the concluding points to which Mr. Allan drew attention were the following:—The Staveley sand-spun pipe was of the same external diameter in the body, and had a socket of the same internal dimensions, as the British standard pipe. It could therefore be used with all British standard straight pipes and specials of the same nominal bores. Due to centrifugal action, a casting without gas cavities, blowholes and non-metallic inclusions was virtually guaranteed, and experience up to the present had amply confirmed this. The tensile strength of the metal was also increased. For these reasons it had been possible to reduce the thickness of the sand-spun pipe as compared with the pit-cast variety. The weight of a 16-ft. sand-spun pipe, the only length made, was approximately that of the standard pit-cast 12-ft. length; hence there was ease in transport and fewer joints. As a sand mould was used in both types of pipe and determined the rate of cooling, the physical characteristics of the metal in both cases were similar. It followed that the sand-spun pipe was not an experimental article, for the purchaser had in these pipes features which were familiar to him, and in addition there was the virtual certainty that the pipe was an all-metal one, and not possibly partly voids or non-metallic material.

DISCUSSION.

Mr. J. H. Morris (Birmingham Corporation Gas Department), moving a vote of thanks to Mr. Allan for his instructive address, said there

* Foundry Trade Journal, May 19, 1932, p. 303.

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were great possibilities as regards the making of cast-iron pipes under this particular system. Advantages that could be claimed for this method were that the pipes required no annealing, and, secondly, that they were spun in sand. The safest material to work iron in was sand. Other advantages in making spun pipes concerned certain stresses that could be set up in the cooling process. There being no core, the casting in itself was a free agent to contract without resistance. The only portion of the pipe that was liable to the slightest resistance was the socket core, and in the making of these pipes it was possible to relieve that core very soon after the pipe had been spun. Another important point was that these pipes were not subjected to the cold atmosphere outside the foundry; they were kept in the same atmosphere as that in which they were spun, and thus were allowed full opportunity for natural cooling.

Mr. G. Callaghan, in seconding, expressed appreciation of the marvellous attention to detail in the plant, and said Mr. Allan had been particularly informative as to detail in his Paper. The vote was carried unanimously.

Flask Details.

Questions being invited, a member of the Midland Junior Gas Association (which body had been invited to attend) and Mr. Callaghan led off. The first questions were: how was coke fed into the cupola; and whether, if metal picked up by the magnetic crane was deposited in the tray while this was in a horizontal position at the height of a man's chest, would it not be rather inconvenient so high? Other questions concerned the possibility of slight error as regards the flasks, and the drilling to ensure complete ventilation of the mould. One speaker recalled that making pipe flasks years ago was an extremely hard job, and described how small tapered cones used to be inserted into the mould to form vent holes. It was interesting to hear that those who put down this large plant were human, seeing that it was found necessary to replace dry grinding by wet grinding. The second speaker mentioned that he happened to have been engaged on conveyors now at Staveley, and asked if the sand storage was not comparatively small, and what was the capacity of the sand hopper? At the knock-out stage the sand temperature must be fairly high, and it would be informing to know what the temperature was when the sand was being discharged into the flask. Also, what was the capacity in tons per hour of the plant, and the actual time the sand took in circuit, working at full capacity from the knock-out to entering the flask at the spinners?

Cupola Charging.

The Lecturer (Mr. J. B. Allen), dealing with cupola charging, said a tilting table was placed in front of the cupola door and sat on a weighing machine. The pig was dropped on to this table direct from the magnet, and the table was tilted to discharge the load into the cupola. As to the coke charge, it was first shovelled into a bottom-opening hopper in the stock yard, and the hopper was picked up by a chain attached to the magnet and carried near the top of the tilting table; the bottom was then released and the charge dropped on to the table, being shot into the cupola in the same way as the pig-iron. Regarding the flask, the vent holes were actually drilled.

Balancing the Flasks.

The chief point so far as centrifugal work was concerned was that the flask must be absolutely balanced, and each one had its cast-iron cylinder machined inside and out. The holes must be drilled most accurately for the purposes of balance. When the tyres were shanked on in place and the whole thing machined, it was put on knife edges and balanced statically, and then placed on a balancing machine and balanced dynamically. Hence, the flasks were quite an elaborate piece of apparatus, and were also a very expensive part of the tackle used. Fortunately these flasks had served them in good stead. During the two years in which the plant had been running only two had been lost. In one of these the original boring, done from the two ends, was found to be wrong and caused the flask to break at an early stage. In the second instance the flask was knocked out of the crane and crashed. The rest of the flasks remained, and moreover were in continuous service, and no trouble was experienced in maintaining them correctly. But it was essential that those parts which fitted the socket pattern at the one end and the portable sand-hopper casting at the other end of the flask should be kept exactly to proper limits.

Small Tolerances.

This plant as a whole started very much easier than any other with which he had to deal. They did not at first quite appreciate the rather remarkable accuracy which was necessary. Taking the patterns—socket and body patterns—of the flask, they had to be within 3,000th of an inch parallel, and the same sort of tolerance applied to most of the tackle, which was quite unusual for a foundry. Naturally this brought a few difficulties in its train. To secure this accuracy they had to instal instruments and machines and get people to read them. Thanks to the aptitude of their staff and workpeople, they were able to do this in a very short time. Despite these exceptional limits, hardly any trouble was experienced thereafter.

Sand Control.

Mr. Allan emphasised that sand control was one of the most important items in the management of plant. The storage was somewhat small for the capacity of the plant. If they had a bunker of 100 tons, instead of a third of that storage, it would render sand control simpler. This control required a good deal of experience and unceasing vigilance to keep the supply right. Control had been brought to an accurate pitch by now, and few sand troubles came along. When discharged the sand temperature was about 100 deg. C., and it lost about 30 deg. on the way round. The time taken for the circuit varied, being dependent on the size of the pipes being made at any one time; they worked three and sometimes four sizes at one time. The smallest pipes they made were 4 in., and these were done in 6-in. flasks, as 4-in. flasks would not be safe enough for general use.

Temperature Limits.

As regards the temperature of the metal before casting in the spinning mould, Mr. Hall asked whether much variation was allowable in this temperature, and if it was higher or lower than for ordinary spun-pipe processes: any sand process with any other combination. Did the analysis affect the time taken in the spinning? The blacking used would probably be quite a considerable tonnage; if so, did the company pulverise its own and what kind of pulveriser was used?

Mr. Allan replied that before casting they tried to tap out at a temperature of about 1,380 deg., and the average drop from the first pipe cast to the last in the ladle varied from 30 deg. to 50 deg. The allowable range varied somewhat according to the metal; fluidity had an important bearing on it, for example. Something below 1,200 deg. was, he thought, the lowest; but this was too low in his view. As to a higher or lower temperature than for other methods of spinning, this of course meant chilled spinning, and he could say nothing definite. Their ideas of temperature had altered a little from the start. At one time for small pipes they thought high temperatures would produce good results, but these proved to be not so satisfactory as pipes done at lower temperatures. Their experience was that 1,380 deg. was a very sound figure, this having been maintained with very good results. He did not think the analysis had any effect on the time of spinning. They tried to maintain a steady analysis. If they were working on a wide range it might have some effect. Their time of spinning was merely an empirical one: spinning could not be too long, but obviously they could spin too short. Therefore they made quite sure of spinning long enough. It could be taken as one minute per inch of diameter, although it varied. Naturally they desired to cut spinning down, but there were risks in doing so to any substantial extent.

Blacking.

The company manufactured its own blacking nowadays, and a Peel mill was used. As its main constituent was coke, and the company made its own coke in another part of the works, this was a convenient addition to their activities. No trouble had been met with in the product since they started running the plant some six months ago.

Another speaker asked, did the metal impinge on the front of the pipe, and were the flasks kept in a horizontal position? Further, was there really any virtue in centrifugal action imparted to the metal, or was the tensile-strength increase rather due to the more efficient rate of cooling of the pipe?

Tensile Strength.

Mr. Allan, remarking that the runners were kept very clean, said the end of the runner projected from the spigot end-plate about ½ in., and the metal impinged on the mould itself at the same distance from the end practically all the time. Provided the condition of the sand was right, there was no trouble as a result of this impingement. That was where efficient sand control came in. The flasks were definitely horizontal. As to centrifugal action in relation to tensile strength, its virtue lay in the fact that the effect of that action was to subject the metal to pressure during solidification, and the cooling was undoubtedly quicker than in the pit-cast variety. There was an obvious reason for this; in the pit-cast variety there was a core, and therefore the metal was between two walls of sand, whereas in the other case it was only up against one, and this had a very definite effect. Further, the thickness was less, and consequently the rate of cooling was quicker. Some pipes produced were found to possess 25 per cent. more tensile strength than pit-cast pipes, and Mr. Pearce reminded him that the spun metal had a greater density.

Synthetic Sands.

Mr. Shotton, inquiring as to the addition of clay wash to sand, asked what kind of clay was used and the percentage added, and also whether any coal dust was mixed with the sand?

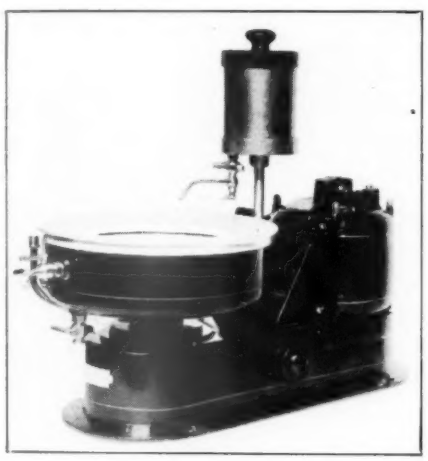
Mr. Allan explained that roughly 5 per cent. new sand was added to make up for the loss entailed in the circuit. There was no natural bond in the sand used. It was a washed sand; hence it was necessary to supply it with a bonding agent. This agent was merely clay wash with a specific gravity of 1.3. The moisture was roughly 7 per cent. when they ran it normally. He was unable to give the quantity of clay wash used. The mixing was done in batches, and the returned sand was sampled before the mixing took place. It was tested by the ordinary method of strength determination, and according to the result they either diluted or did not dilute the clay wash; this had been converted to so many inches of water in a measured vessel, and it varied considerably. This was where the skill of the individual who looked after this particular section entered. Their sand control was under a chemist, who also exercised control over the iron, and was directly responsible to the chief chemist of the whole of the foundries. The chemist had an assistant who did nothing else but test sand the whole time. Sand tests were taken at least every five minutes throughout the shift. Coal dust was not used.

(*Concluded on page* 370.)

A New Metallurgical Polishing Machine.

A new metallurgical polishing machine, Mark II, has been designed and placed on the market by Messrs. E. W. Jackson & Son, Limited, of Cheswold Works, Doncaster. The machine is entirely self-contained, and the electric motor, which drives it, has been built into the design and fixed in such a manner as to provide both strength and accessibility. Throughout the construction the very best materials have been employed for their respective purposes, the design is of a robust character and with adequate bearing surfaces, the weight of the revolving table is taken by a ball-thrust bearing, of ample dimensions, and mounted with every consideration as to lubrication and exclusion of grit and abrasive matter from the bearing housing.

The revolving table is designed to carry the metal-polishing discs which carry the polishing cloths, and these latter are fixed by means of spring garters, which stretch the cloths securely in position. This method of fixing allows the cloths to be quickly detached, and the discs are



The Mark II Polishing Machine.

accurately centred and located on the spindle and driving peg.

Careful consideration has been given to the freedom from rust particles in connection with the polishing unit, and the employment of suitably rustproofed parts eliminate any cause of trouble under this heading.

Splash Guard.

This is of ample size and rustproofed, and has high sides to take care of the liquid which is used when wet polishing is being carried out, also the trough is fitted with both level tap and drain tap, and the bottom of the trough is "dished" towards the outside to make for better draining and cleaning out. A detachable hand-guard ring is fitted, which is easily removed for renewal of the polishing disc, and this guard also acts as a support for the hand whilst actually polishing, ample clearance is given between the trough sides and the disc to allow for easy removal.

A water-drip tank is arranged from a small tank, the supply of water or other liquid being regulated by the feeder tap, and this can be swivelled in various positions; the tank also is adjustable for height, this feature being extremely convenient when a lengthy specimen is being dealt with. The base of machine is of rigid box section and carries the motor, which is fixed to supports cast integral with the base, the forward end of the casting carrying on a machined face, the spindle-bearing support; arrangements for adjusting the driving belt are provided for by means of slots in the base of the spindle-bearing support.

Electric Motor.

This has been specially selected and incorporated after careful tests, and the machine can be arranged for a.c. or d.c., with the usual voltages. The polishing head is driven by belt from the motor, and this method eliminates any chance of wet-polishing compound reaching the motor with resulting damage, and positively prevents any chance of short circuit or "shock" from this source. The motor is well made and is of the highest quality and is arranged with an internal centrifugal starting switch which eliminates any necessity for complicated switch gear, and enables one tumbler switch to control the starting and stopping. The switch is covered in Bakelite and shockproof and the whole of the wiring is well insulated. A length of cable is supplied with each machine and finished off for connection to a lamp socket; also an "earth" terminal is provided on the motor to connect the machine suitably to earth, thus conforming to Electricity Regulations and preventing any chance of damage.

The driving belt is woven from best-quality flax and is an endless weave, therefore an exceptionally smooth drive is assured and the stretch is eliminated as far as possible, and owing to the special design it is impossible for oil to cause trouble on the belt, as provision has been made to guard against this.

Speeds.

The speed of the revolving table is 1,000 r.p.m. as turned out as standard, but a slight variation can be made by altering the pulley ratio to suit requirement. As the disc, however, is fairly large in diameter, a variation in polishing speeds can be made by working nearer to the centre or nearer to the outer edge. The motor is lubricated by self-feeding bearings, and requires only a few drops of light machine oil every four to six months, and the lubrication of the polishing head is by means of a snap lubricator at the side of the machine; this should have a few drops of good-quality engine oil put in before commencing, depending on the amount of work being done.

The whole machine is well finished throughout, and the materials used are of the best quality, the drip tank being brass and the hand guard in polished aluminium, whilst all taps and fittings are of the best quality. Each machine is sent out ready for immediate use with one polishing disc, electric-motor belted and having been tested before delivery, and is complete with tank, spring garter for securing the polishing cloth and spanner for adjusting the driving belt should this be required.

Thermal Spalling.

(Concluded from next column.)

In conclusion, it should be noted that to minimise the risk of spalling in firebricks, the following points are of importance:—(*a*) Lighting up should be done with coal fires. Wood and oily waste give too much flame for the surface of the cold brickwork; (*b*) the slowest practicable heating and cooling of the bricks under 800 deg. C.; (*c*) the use of bricks of standard sizes in place of large special shapes and of shapes with severe changes in mass and section, and (*d*) the adoption of special-quality bricks where very fast heating and cooling cannot be avoided. Well-burned silica bricks have a large reversible thermal expansion between 200 to 300 deg. C., and it is, therefore, always essential to heat and cool silica brickwork slowly through this dangerous period.—*From Refractories Bulletin No.* 15.

Thermal Spalling.

In furnace work trouble is sometimes experienced with the bricks splintering and cracking and pieces frequently become completely detached. Technically this phenomenon is known as spalling. The root cause of spalling is that the dimensional changes which occur in refractories when they are rapidly heated and cooled, create stresses which are sometimes sufficient to produce fracture.

Whether a material cracks or not when subjected to thermal shock depends on several things. For instance, it can be said that if the coefficient of expansion of a material is very low, no excessive strains and resultant stresses are produced and the material will be highly resistant to thermal shocks. Thus, fused silica and corderite ($2MgO.2Al_2O_3.5SiO_2$), with extremely low coefficients of expansion, give bodies which have very high spalling resistance.

The converse also holds, for materials which have a high coefficient of expansion—silica, magnesite, zirconia and thoria—are markedly susceptible to thermal shock. Also, it can be said that if a refractory transmits heat rapidly, no steep uneven strain and stress gradients will be set up, and high resistance to temperature changes will therefore be shown. Silicon carbide and beryllium oxide, both good heat transmitters, show high resistance to spalling.

If a material of infinite strength is strained by sudden heating or cooling, it will remain un-

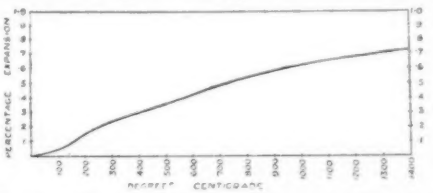


Fig. 1.—Showing Typical Expansion Curve of Firebrick.

fractured, and again, if a material has great elasticity and flexibility, the stresses will be relieved by distortion instead of by rupture. It is seen, therefore, that (*a*) low coefficient of expansion, (*b*) high rate of heat transmission, (*c*) high strength and (*d*) high flexibility are the factors which favour resistance to sharp temperature changes. In manufacture the maker has little, or no, control over (*a*) and (*b*), but he can adjust (*c*) and (*d*) considerably and so is able to supply, if necessary, bricks which have special resistance to spalling.

In Fig. 1, is shown the typical expansion of a good-quality firebrick. Most of the expansion is complete at 800 deg. C., and since the elasticity increases rapidly above 800 deg. C., it follows that the chief danger of spalling in a firebrick lies below red heat, where the expansion and rigidity are both high. Firebricks generally become more and more sensitive to temperature changes the longer they have been at the working temperature, this increased sensitivity being due to further vitrification and reduced elasticty of the material.

Bricks which have been insufficiently burned in manufacture have a residual contraction and the persistence of this contraction in use causes the formation of a very dense layer which is highly sensitive to temperature changes and tends to break away from the body of the brick. Likewise, bricks which are not refractory enough for the imposed heat duty develop a highly vitrified layer which is easily cracked. Cases such as the above are often referred to as "structural spalling." This type of spalling can be lessened by maintaining an oxidising atmosphere, since both shrinkage and vitrification are much aggravated under reducing conditions. For complete elimination, however, better quality refractories must be used.

(Concluded in previous column.)

XUM

Bismuth in Copper.

The Fiscal Policy Technical Sub-Committee of the brass and copper industries, through their chairman, Mr. A. J. G. Smout, and secretary, Mr. J. Lester Smith, have sent us the following important communication on the subject of bismuth as an impurity:—

"In view of various developments which have recently taken place in the metallurgy of copper and brass, the effect of small proportions of bismuth upon the mechanical and other properties of these materials has assumed greater importance than ever before. Simultaneously, the development of various sources of copper which may contain more or less bismuth has rendered it supremely important for the manufacturer to be able to know with certainty the bismuth content of the metal he is employing.

Since the proportions of bismuth which have to be determined are very small, the actual estimation is an operation which presents considerable difficulties, and a careful examination of the whole position by the Technical Sub-Committee of the Fiscal Policy Committee of the brass and copper industries has shown that there is generally a good deal of uncertainty in the assays which are made. Since the bismuth content affects the buying and selling of many thousands of tons of copper per annum, it is obviously essential that entirely sound and reliable results shall be obtained when analysing for this element, and in an endeavour to arrive at such a position, the above-mentioned Technical Committee has thoroughly investigated the matter.

As a result of this examination, a set of principles has been enunciated by the Committee which they consider will, in the hands of competent analysts, produce reliable and reproducible figures. In making a statement of these principles, the Committee does not wish it to be believed that it is excluding other possible methods, but wishes to affirm that in laying down certain rules it has produced a means whereby sound analytical results can be obtained.

In view of the exceedingly great importance of securing the most complete reliability in analysing for bismuth, the Committee would be grateful if you would arrange to give publication to the document enclosed and also to this letter, which explains how it came into existence. It is hoped that by these means, all those who are interested in this problem will have an opportunity of seeing and criticising these proposals with a view to the eventual perfection of this particular determination, and the Committee will be glad to receive from interested parties any comments or suggestions tending towards this result. These should be addressed to the secretary, Mr. Lester Smith, c/o Squiers & Company, King's Court, 115, Colmore Row, Birmingham."

THE ESTIMATION OF SMALL PROPORTIONS OF BISMUTH IN COPPER. (UP TO 0.020 PER CENT.)

In dealing with this matter, it has been considered desirable to enunciate those analytical principles which should be observed in making an analysis for bismuth, rather than to lay down details of chemical procedure. The intention is to provide a set of rules which, in the hands of competent analysts, will produce reliable results. Within the principles enunciated, there is ample scope for variation in accordance with individual preference. It is not claimed necessarily that the methods which would follow from the given rules are the only ones which may give reliable results, but it is claimed that the principles set out below, if faithfully observed, will always yield reliable and reproducible values.

The proportions of bismuth in question are too small to allow of satisfactory determination by gravimetric means. If a gravimetric estimation is attempted, it is necessary to use a very large quantity of material and, as a result, the operations involved in the separation of the bismuth become too clumsy for the requisite accuracy to be obtained. Furthermore, the handling of the final precipitate presents marked difficulties in view of the small quantity which is present.

The most satisfactory method of determining the bismuth is by colorimetric means and a suitable reaction for this purpose is that between bismuth sulphate and potassium iodide. This reaction releases bismuth tri-iodide, which dissolves in an excess of potassium iodide, producing a yellow solution.

In opening out the copper, solution should be effected by nitric acid. 10 m.l. of nitric acid (Sp. Gr. 1.20) per gram of copper is a suitable allowance. In the event of an insoluble residue being obtained this should be filtered off, ignited and fused with potassium-bi-sulphate, the fusion dissolved in dilute sulphuric acid and added to the original filtrate.

In order to ensure that the whole of the bismuth is precipitated during separation, it is necessary to have present a sufficient quantity of another element to act as a collector. Of the various elements which might be employed, iron is the most satisfactory. In impure coppers there may be sufficient iron present to act as a collector, but in view of the uncertainty of this iron content, it is preferable to make a specific addition of iron to the dissolved sample. (0.25 grams of ferrous ammonium sulphate per 10 grams of sample is a satisfactory proportion.)

In precipitating the bismuth, the caustic alkalies should be definitely avoided and an entirely satisfactory precipitant is ammonia. Re-precipitation of the mixed hydroxides of bismuth and iron is essential in order to avoid contamination of the bismuth solution finally obtained, with copper.

The complete precipitation of the bismuth requires some considerable time, and it is necessary to allow the solution, both for the initial precipitation and the re-precipitation of the bismuth, to stand in a warm place for at least six hours.

When the final precipitate of the mixed hydroxides of iron and bismuth, from which the copper has been completely removed, is re-dissolved, solution should be effected in sulphuric acid. The resulting solution should be neutralised, then brought to a condition of slight acidity, after which all the iron must be reduced to the ferrous condition. The reduction can be effected most conveniently by means of sulphurous acid.

The final solution is matched against a blank solution, which has been prepared by carrying through all the analytical operations as applied to the sample under assay, but to which no sample has been added. Into this resulting solution the standard bismuth solution (containing 0.0001 grams bismuth per m.l.) is added until the colours match. The bismuth solution is best prepared by dissolving 0.1 grams of metallic bismuth in 20 m.l. concentrated sulphuric acid and making up to a litre.

In the final solutions the acidity should be approximately 2 per cent. by volume, and the amount of potassium iodide added should be adequate but not excessive. A suitable proportion being about 10 m.l. of a 2 per cent. solution. The aliquot proportion taken of the solution under assay should be such that not more than 4 m.l. of the standard bismuth solution should be required.

For proportions less than 0.002 per cent. of bismuth, the methods based on the above principles may not be trustworthy. Methods for the determination of these very small proportions are at present under investigation.

An exhibition and demonstration of electric heat-treatment furnaces and equipment was opened at the Leeds Corporation Electric Power Station on May 17, and will be continued until Saturday, May 27.

German Foundrymen's Technical Association.

ANNUAL MEETING, 1933.

The 22nd annual meeting of the German Foundrymen's Technical Association is being held at Berlin on June 10 and 11, when the following Papers will be read:—"The Danger in Foundry Practice of the Non-Opposition of Vague Patent Specifications," by Dr. R. Stotz, Düsseldorf; "The Principles of Costing in Foundry Practice," by J. Petin, Hannover; "Alloy Cast Iron," by Dr. C. Pfannenschmidt, Cologne; "Primary Crystallisation of Cast Iron," by Dr. F. Roll, Leipzig; "The Mechanical Strength of Weldings and Castings," by Prof. Dr. A. Thum, Darmstadt; "Technology and World Civilisation," by Dr. G. Feder, Münich.

Advanced Lectures on Foundry Technology.

In connection with the annual meeting, the Technische Hochschule of Berlin, in co-operation with the German Foundrymen's Technical Association, the German Institute of Metals, and the German National Association of Non-Ferrous Founders, has organised a series of advanced lectures on foundry technology on June 12 and 13. The following lectures will be delivered:—"Silumin, its Historical Development," by Dr. W. Klaus, Berlin; "Technical Problems in the Production of Aluminium Castings," by Dr. J. Dornauf, Frankfurt-am-Main; "Constructional Technology of Aluminium Castings," by W. Hartl, Frankfurt-am-Main; "Zinc Alloys for Castings," by E. Rossow, Berlin; "Scientific Foundry Practice, 1923-1932, in Germany: A Review of Recent Development and Future Trends," by Dr. W. Claus, Berlin; "Development of the German Metallurgical Industry using German Materials," by Prof. Dr. W. Guertler, Berlin; "Practical Experience with the K.S. Ellipsoidal Rotary Furnace," by F. Höhne, Leipzig; "Testing of Castings, Acceptance Tests and Preparation of Representative Samples," by Dr. W. Claus, Berlin; "Nickel and Nickel Alloys," by Prof. Dr. W. Guertler, Berlin; "Position and Development of the Pressure Die-Castings Process," by Dr. W. Brunnckow, Berlin. A film illustrating die-casting will also be exhibited. Non-members of the Association may attend these lectures at a cost of 12 Rmk.

Application of X-Rays in Foundry Practice.

The Ferrous Metals Institute of the Technische Hochschule has organised, also for June 12 and 13, a series of lectures dealing with the application of X-rays in foundry practice, to be followed by discussions and demonstrations in the radiology laboratory of the Institute. The following lectures have been arranged:—"X-Rays as an Aid in Testing and Research Work in Foundry Practice," by Prof. Dr. G. Sachs, Frankfurt-am-Main; "Examination of the Structure of the Heavy Metals by Means of Gamma Rays," by Dr. M. Widemann, Berlin; "X-Ray Testing of Materials *in Situ*," by W. Rosteck, Berlin. Non-members of the Association may attend these lectures and demonstrations at a charge of 10 Rmk.

Sheffield University Metallurgical Researches.—The University of Sheffield has published a report of research work carried out during 1932 by the department for the cold-working of steel and other ferrous metals. In addition, investigations are fully described on wires submitted by the Patented Steel Rope Association, on the hardness of wire, the drawing of mild-steel bars, the Johnson & Brunton bend-testing machines for wire, and deep stamping defects. A full summary of reports of mechanical tests of cold-worked materials presented to the Cold-Working Committee, to December, 1932, is also given. Concise information of the chemical and physical characteristics of the wires and materials tested is tabulated in the appendices.

James Watt Memorial Institute.

OPENING CEREMONY AT BIRMINGHAM.

A distinguished gathering, numbering some 250 people representative of the engineering industry in all its branches, witnessed the opening on May 15 of the new James Watt Memorial Institute at Birmingham. The ceremony was performed by Mr. Alan E. L. Chorlton, M.P., President of the Institution of Mechanical Engineers, and among those representing the I.B.F. in the Midlands were Mr. J. G. Pearce, M.Sc., M.I.E.E. (Director of the British Cast Iron Research Association, Birmingham), Mr. E. J. Lewis (President of the Birmingham, Coventry and West Midlands Branch), Mr. G. M. Callaghan (Junior Vice-President) and Mr. L. W. Bolton (Secretary). When the centenary of James Watt was celebrated in 1919 at Birmingham a fund was initiated which it was hoped would provide for a chair of mechanical engineering at Birmingham University, together with a building worthy of the inventor, forming a home for various engineering societies. However, owing to trade conditions, the fund fell far short of what was required: £20,000 was needed for the "chair," and the cost of a separate building would be about £40,000.

What has happened is that £5,000 has been devoted to a research scholarship in the mechanical engineering department of the University, £500 was spent on a memorial volume devoted to Watt and his work, and the £6,000 that remained has since then grown to £10,000 Hence, as Sir Gilbert Barling (lately Vice-Chancellor of the University and chairman of the trustees) said, it was considered desirable to proceed on moderate lines rather than wait for an indefinite period. The Institute forms a wing of the newly-erected York House, in Great Charles Street, and comprises a lecture hall, library, committee room and other accommodation. Towards the yearly cost of £800 some £650 to £700 is assured.

Inventions and Waiting Ideas.

Mr. Chorlton, in appraising the genius of Watt for thorough investigation and grasp of detail which enabled him to master mechanical problems and turn them to practical use, said that at the same time it was doubtful whether Watt would have achieved so much success but for his profitable association with Matthew Boulton. The latter's practical mind and business ability were complementary to Watt's genius for scientific and research work, and their association was more complete than in any other instance of science or engineering. In a general sense the stationary steam engine of to-day showed remarkably little difference from the earlier engines; just as the locomotive had not changed a great deal in principle since the days of George Stephenson, except in size, speed and boiler pressure. Engineers to-day found that whenever they departed from the convention of practice in engineering and in starting on a new shape and design, they were brought up against new problems; and nothing short of dogged perseverance and the facilities to proceed would in the majority of cases enable them to succeed. Indeed, unless they were prepared to persevere and had the necessary facilities, it was wiser to stick to the old way. Observing that in Watt's day England was rapidly assuming or gaining the leadership of the industrial world, Mr. Chorlton said it was very largely due to these early engineers. The great cotton industry was rising up, but not until the steam engine became a practicable proposition did it expand at the rate the world demanded. In that sense Watt was one of the forerunners of the industrial revolution, just as Arkwright was from the cotton-spinning point of view. The world was in just as urgent need for inventions to-day as then; and the new Institute, by bringing men of trained minds together, promoting goodwill and sympathy in the propagation of ideas, would do much to foster the spirit of invention. England depended for regaining its industrial supremacy on new machines and new processes almost more than anything else. Some people doubted whether such great developments were again possible; but there must be room for further ideas, and his opinion was that there was still as much to be brought out of the unknown as had been discovered in the past, and perhaps even more. Mr. Chorlton added that in the Institution of Mechanical Engineers they were considering whether they could devise some special means for helping engineers who put forward good ideas, with a view to turning these ideas to practical use.

The Importance of Watt's Work.

Mr. R. A. Chattock (a trustee and formerly the City Electrical Engineer for Birmingham), observing that it had been claimed that Watt invented the steam engine, stated that engineers were aware that working steam engines were in existence before he began his experiments. However, there was no doubt that as a result of these experiments Watt laid the foundations upon which these marvellous structures had been built up. In later times the application of the work of another great man, Faraday, was only rendered possible by being coupled with the driving force of the steam engine. Without the steam engine he could not visualise the large electric power stations which had grown up all over the world. It was true that the engine which Watt designed was not used in these large stations, but he would point out that the Cornish cycle was still used in the turbines which were installed in them. Describing the passage of the steam in both cases, Mr. Chattock said the positive assertion could be made that the same principle applied to the turbine as to the old Cornish cycle.

Although the Area Branch of the I.B.F. has not considered it advisable to take part in a joint programme arranged by the metallurgical societies supporting the venture, it is open to any member to join the Watt Institute, towards the fund for which many have already subscribed individually.

Testing of Mechanical Brakes.—In "Zeitschrift des Vereines deutscher Ingenieure," K. Kutzbach discusses the testing of mechanical brakes and the relative efficiencies of brake shoes, describing the experimental work carried out for this purpose with special reference to the coefficients of friction of the surfaces in contact and the physical conditions obtaining during braking.

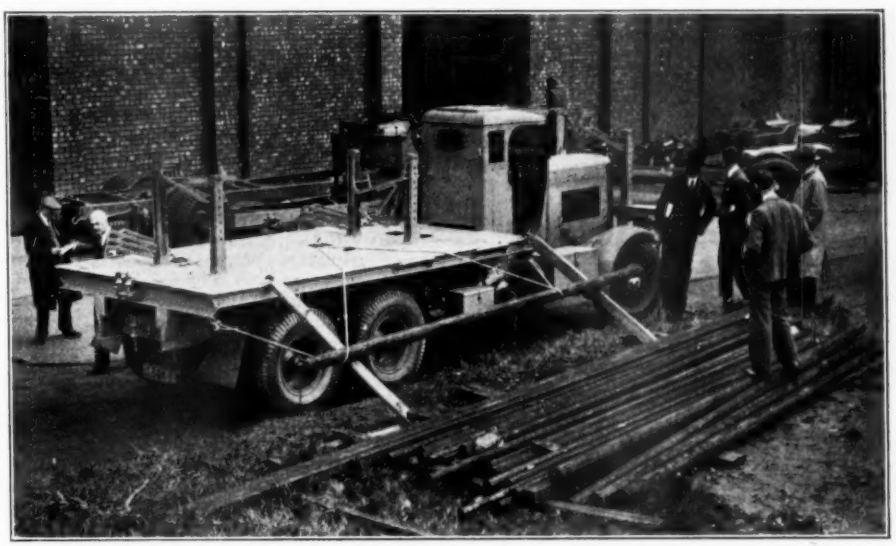
Ingenious Pipe-Laying Vehicle.

ELIMINATES MAN-HANDLING

The accompanying illustration shows a special pipe-laying vehicle built by Leyland Motors, Limited. This vehicle, without the aid of a crane, will pick up, load, transport over rough ground and lay pipes, of diameters varying up to 4 ft. and up to 40 ft. in length, with the least possible labour. The machines are constructed to carry pipes forming a total load of approximately 7 tons.

In order to handle pipes of considerable length provision is made for them to be loaded along each side of the cab so that they can extend over the full length of the machine. Further, in order to provide accommodation for as many as possible, the cab width has been cut down to the very minimum which will allow of reasonable comfort for one man. The steering and all controls have been centralised to come well within the cab.

The pipes, when in position, are carried on three bolsters on each side of the vehicle. On each of these bolsters are a series of pipe clamps which can be placed over each layer of pipes. These clamps, in addition to forming a method of securing the pipes without the necessity for any lashing, form beds for each succeeding tier. The clamps run in adjustable sockets in order to accommodate varying diameters of pipes and any number of lengths. Loading or unloading is accomplished by means of hawsers which work from niggar-heads located on each side of the chassis just below the level of the driver's cab. These niggar-heads are driven by a duplex chain through a special two-speed gearbox having a forward and reverse motion from an auxiliary drive taken from the main gearbox. When loading the offside, the nearside niggar-head is used, a hawser being placed round the niggar-head and run round rollers up through holes provided in the centre of the platform and thence over further rollers on the side of the body and around the pipe to be loaded. Off-loading is carried out in a similar manner, the bar or pipe being let down by the hawser but utilising the niggar-heads running in the reverse direction.



View of Leyland Pipe-Laying Vehicle.

A big contract for machine tools, formerly made in Germany, has just been placed with Messrs. Kryn & Lahy (1928), Limited, of Letchworth. The German firm concerned finds that products for the British market can now be more advantageously made in this country.

Recent Developments in Metallurgy.

AGEING AND AGE-HARDENING.

At a meeting of the London Section of the Society of Chemical Industry which was held at Burlington House, London, on Monday, May 1, Dr. J. J. Fox in the chair, Dr. C. H. Desch read a paper on "Recent Developments in Metallurgy," in the course of which he referred specially to the phenomenon of ageing and age-hardening of metals, a field in which, he pointed out, great developments have taken place during recent years and the importance of which was increasing. The phenomenon of ageing in metals, continued the author, was probably first observed when the alternating-current transformer was invented and put into service. The sheets used for building up the cores of these transformers were made either of wrought iron or dead-soft steel, and it was found that the magnetic properties deteriorated during use. At that time the subject of mechanical fatigue in metals was attracting a good deal of attention, but experiments by Mordey proved that this deterioration was not due to magnetic fatigue, as it had been thought reasonable to assume. It was ascertained that during the running of the transformers the iron or steel became heated to a temperature in the neighbourhood of 60 deg. C. and if maintained at that temperature for some time the magnetic properties deteriorated. With the advent of Hadfield's 4-per cent. silicon steel it was found that this difficulty did not exist and this material displaced soft steel for transformers. The subject of ageing was then allowed to drop for some time until it became prominent again in connection with boilers in which the deterioration of mild steel took place at a temperature above the normal, if maintained for a considerable time. A certain brittleness occurred, and one engineer in this country—Stromeyer—associated this effect with the presence of nitrogen in the steel. Again, however, the problem was not followed up, ageing being simply accepted as a fact.

Duralumin.

In 1911, however, a new alloy, duralumin, was introduced which contained about 4 per cent. of copper and 0.5 per cent. of magnesium, and it was soon found that this changed its mechanical properties spontaneously in the course of time in an apparently inexplicable way which was very troublesome to deal with because it was impossible to predict what was going to happen next. Then it was found out empirically that when this alloy was subjected to a certain heat-treatment its mechanical properties could be varied and that practice was now invariably followed, the most suitable heat-treatment being applied to give the best mechanical properties for the purpose in view. That fact was found out empirically in the workshop but the fact was not explained until considerably later when three workers in the U.S. Bureau of Standards put forward the theory that the hardening of the alloy was due to the presence of the compound $CuAl_2$, which was undoubtedly present in the material and entered into solid solution with aluminium at a high temperature. Its solubility at lower temperatures was very much less. It was suggested by these American workers that there was a certain critical state of dispersion which produced the maximum hardening effect. It was obvious, continued the speaker, that if this were so the same phenomenon should be observed in other alloys where similar solubility relations occurred and that, in fact, had been verified to the extent that there were now a score or two of alloy systems in which this hardening can occur.

The matter, however, was not so simple as it at first appeared, and a great deal of further work had been done on the subject, particularly by Hanson and Gayler at the National Physical Laboratory, who found that the hardening was not due entirely to the $CuAl_2$ compound but that magnesium was always present in the alloys which showed the typical age-hardening. One alloy which showed the phenomenon in a peculiarly-marked degree was the copper-beryllium alloy. The firm of Siemens in Germany first introduced about 2½ or 3 per cent. of beryllium into copper and produced an alloy with very high-elastic properties suitable for springs. This alloy showed age-hardening to a very marked degree, but the study of it had indicated the proportions to be used in order to give the desired results. That was one of the most striking cases of age-hardening, and the study of it had provided a great deal of material for judging the nature of the process.

X-Ray Evidence.

A serious objection to the acceptance of the American theory that the age-hardening was due to dispersion, was that whereas one would expect the electrical conductivity of a material to increase if the dissolved impurity came out of solution, as a matter of fact, it actually decreased in the first stages of hardening, although it rose afterwards. The X-ray evidence was also against the dispersion theory as a simple theory, but, perhaps, too much emphasis had been placed upon the results of X-ray investigations. Rosenhain had suggested that the electrical conductivity difficulty could be overcome by assuming that precipitation went on in the manner suggested by the early American workers, but that in the early stages of precipitation, the particles coming out were very fine as they were finding their way through the lattice, and that gradually a distortion of the lattice took place which led to a higher resistance than in the undistorted part. Therefore, the first stage was to bring about such a distortion as would account for a change in the electrical conductivity. That answered that point satisfactorily, but the X-ray evidence was a little uncertain. There was, however, every reason to suppose that when the precipitation did occur, there was definite crystallographic relation between the precipitant and the parent solid solution.

Case of Mild Steel.

Referring to mild steel, the author said that when age-hardening occurred in duralumin and certain other alloys, it was thought to be peculiar to them, but work by Koster showed a close relationship between what happened to these light alloys and what happened to mild steel, and the idea of Stromeyer that nitrogen played an important part in this case turned out to have a very great probability. Nitrogen was found in most mild steel in varying quantity, according to the process of manufacture, and was at a maximum in basic-Bessemer or Thomas steel, the solubility relations being such as to bring about age-hardening. The complete relations of nitrogen and iron had been completely worked out, and the ageing of mild steel had been very largely attributed to the influence of the nitrogen. Those steels which contained the least nitrogen showed the least tendency to undergo age-hardening. The silicon steel which replaced soft iron for transformers contained practically no nitrogen, and it did not show ageing. At the same time, the possibility of the effect of oxygen and carbon on ageing must not be ruled out.

An interesting fact about age-hardening was that it was greatly accelerated by cold-working and that was quite in accordance with the precipitation theory. Another phenomenon connected with steel which had long been known, but never explained, was that most metals become weaker as the temperature increases, but iron and steel gave a curve which showed a minimum at about atmospheric temperature, then rose to a maximum at about 20 or 30 deg. C., and then fell away to very low figures. Within a certain range above atmospheric temperature it was dangerous to apply deformation to steel. It must not be hammered at blue heat, because it would engender weakness. The blue-brittle range in steel corresponded closely with the range of temperature within which precipitation occurred, and attempts had been made to link up the two phenomena. The author said he doubted whether pure iron free from nitrogen, oxygen and carbon would show such phenomena, and it was in all probability due to the presence of these impurities which, at that temperature, were precipitated. An immense amount of attention had been devoted to the subject in recent years and all the resources of modern X-ray technique had been brought to bear on the problem.

Conclusions.

In conclusion, the author said the various views he had indicated fitted in quite well with the facts, but the X-ray evidence had to be interpreted with a certain amount of caution because they represented an average of the behaviour of a considerable mass of metal and did not indicate what was happening in very minute films. At the present time, X-ray technique did not enable us to resolve these and for that reason X-ray evidence was rather ambiguous. A good deal of refined X-ray technique, however, was being brought to bear on making analyses of the distribution of intensity within the different bands by using ionisation spectrometers and with photographic methods it was possible to arrive at conclusions as to the behaviour of these small films which were beyond the reach of ordinary X-ray methods. That was the kind of work now being carried out in various countries, and it would throw a great deal of light on the problem, but the one fact already established was that whereas the various classes of phenomena were until recently regarded as quite distinct they had been brought together and shown to be due to one particular cause, viz., nitrogen.

Sand-Spun Pipes.

(*Concluded from page* 366.)

Other Methods.

Mr. J. H. Morris remarked that it would be interesting to the audience to have compared the other methods of pouring metal for pipe-making in view of the description which the lecturer had given of the very efficient method employed by the Staveley Company. Mr. Allan, in reply, mentioned that the three general methods of pipe production were pit cast, chilled spun and sand spun, and proceeded briefly to describe the differences in the methods of pouring.

At the close the Branch-President (Mr. J. G. Pearce) said the Staveley plant opened a new chapter in the foundry history of this country, and from Mr. Allan's address they would appreciate that the price of freedom from trouble meant unceasing vigilance. In no respect was this more true than in the case of sand control, and this underlay the importance of a good deal of the work that had been done in this country during the past few years. The day would come when every firm would find control essential if it was to continue to function. They were to be congratulated on hearing a talk given in such a frank way, with no attempt to hide difficulties or the successful way in which they had been overcome. The Staveley Company was to be congratulated on the courage shown in putting this plant down at the time they did. Iron pipes were essential to their civilisation in connection with water, gas, sewage and effluents generally, and formed perhaps the most important part of their export trade in this particular material. For if they were to take their export figures and deduct cast-iron pipes there would, apart from special machines, be a comparatively low proportion left.

This Week's News in Brief.

Trade Talk.

The Renishaw Iron Company, Limited, Derbyshire, have decided to relight a blast furnace which has been shut down for about fifteen months.

The employees of the Atlantic Engine Company (1920), Limited, Atlantic Works, Wishaw, have given donations to various charitable institutions amounting to £96 3s. 11d. during the past year.

Following a period of steady employment since the commencement of the year, the works of the Steel Company of Scotland, Limited, at Hallside, Newton, have become very slack, and about 400 men have been suspended indefinitely.

What is believed to be the oldest smelting furnace in Lanarkshire is to be dismantled at the works of Messrs. John Williams & Company (Wishaw), 1922, Limited. The furnace, which was the first installed at these works, has been preserved as an interesting relic for over thirty years.

The Blackpool Transport Committee have decided to close down the foundry run by the undertaking. This means that contracts of over £10,000 per year will be given to Preston firms for the manufacture of castings and other fittings. About twenty men will be employed as a result of the decision.

The members of the Glasgow & West of Scotland Association of Foreman Engineers and Draughtsmen accepted an invitation to visit the works of Messrs. Shanks & Company, Limited, manufacturers of sanitary appliances, etc., Barrhead. The party was large, and all the members exhibited a keen interest in the various processes of manufacture.

A cargo of 6,250 tons of iron ore arrived in the Clyde on Friday for a Glasgow steel-manufacturing firm. It was brought from Bona, in North Africa, by the Norwegian ship "Mari," and is the second cargo of its type since January. It is understood that the contract provides for 19,000 tons of ore, and that the third consignment will arrive within the next few weeks.

Sunderland Town Council have decided to petition the Government asking for legislation to make it illegal for a ground landlord to enter into any covenant restricting the future use of land adjoining waterways which has been used for shipbuilding and kindred trades. This step is a result of the activities of National Shipbuilders' Security, Limited, in buying up redundant yards.

The Blantyre Engineering Company, Limited, near Hamilton, Lanarkshire, have secured several additional contracts for washing and screening plant, including one equipment for a colliery near Edinburgh and one for a colliery at Shotts. The additional contracts will enable the firm to reinstate a considerable number of men who have been suspended for some time. It is expected that a number of further contracts will be received by the company in the near future.

Messrs. Alexander Turnbull & Company, Limited, specialists in valve manufacture, St. Mungo Works, Bishopsbriggs, have amalgamated with Messrs. James Howden & Company, Limited, Scotland Street, Glasgow, and the manufacturing activities have been transferred to Messrs. Howden's works. The business in general engineering, valve making and founding has been in operation at Bishopsbriggs for about 60 years, but it is anticipated to speed up production and development work by the fusion of interests between the two firms.

A serious fire occurred in the early hours of the morning of May 18 at Clyde Ironworks, Tollcross, which belongs to Messrs. Colvilles, Limited. The fire originated in the joiners' shop, a large stone-built, one-storey building, and spread rapidly through the roofs of other shops. Notwithstanding the efforts of the Cambuslang and Bellshill fire brigades, the buildings were completely gutted, and damage estimated at over £5,000 was done to valuable machinery, patterns and tools and machinery in the engineering departments. Arrangements have been made to continue business as usual.

This year the students of the Paris Foundry High School, for their annual excursion, visited the works in the North of France under the supervision of Mr. Ronceray. The following establishments were included:—Bracq Laurent at Achicourt; the Vicoigne, Noeux and Drocourt mines; the coke ovens and generating station at Beuvry; the Denain Anzin works; and the Cail Company. This excursion permitted the students to examine the process of loam moulding, manufacture of locomotive cylinders, electric-furnace melting and many other subjects covered by the course at the college.

We understand that the directors of Combustion Engineering, Limited, Aldwych House, London, W.C.2, have decided to place the laboratory services of the company at the disposal of all interested. It is pointed out that the highly technical conditions which dominate the industrial world to-day make obvious the advantages of scientific control, and it is to that end that their laboratory services are offered. The firm have published a small booklet entitled "Laboratory Service and Technical Bureau for Coal and Water," giving a brief survey of the services offered.

The Northern Coke Research Committee, in its annual report, states that it proposes to examine the behaviour in the cupola of a number of cokes prepared under different carbonising conditions (*e.g.*, from the same coal, in narrow and wide ovens) and to correlate this behaviour with that observed in certain laboratory combustibility tests. The combustibility test devised in the Committee's laboratory has been modified to obtain a greater differentiation than was hitherto possible in the results obtained with foundry cokes. A simplified form of the test is also being examined. These two tests will be applied to the examination of the cokes previously tested in the cupola.

It is reported that one of the proposals following the recent approval of the bill enforcing the amalgamation of all private and governmental iron and steel plants in Japan is that as soon as the new corporation has been organised and is on a sound financial basis, the import duty on iron and steel products into Japan should be reduced. This proposal is being supported by importers and consumers in Japan, who wish to see the cost of iron and steel products reduced. The pig-iron manufacturers object to the plan, stating that even with the recent 35 per cent. increase in tariffs, local market quotations have not risen to a point where they are able to show any substantial net profit. They also maintain that pig-iron from India would again be introduced into Japan should import duties be lowered.

Obituary.

Mr. John Wm. Pitt, who died on May 19 at Brighton, aged 80, was a member of an old Spen Valley (Yorkshire) family, closely associated with foundry work in that area for many years. He was the eldest son of the late William Pitt, of William Pitt & Bros., ironfounders and machine-tool makers, of Cleckheaton, and a pioneer in the making of sewing machines. On dissolution of the partnership in 1873, William Pitt established himself at Alma Foundry, Liversedge, an undertaking which was taken over in 1888 by Mr. John Wm. Pitt. Later he bought and enlarged the Providence Foundry, Heckmondwike. Mr. Pitt acquired considerable property in the Spen Valley towns, but disposed of most of it when he sold his works in 1904 and retired to Bridlington, where he gained a wide repute as the builder of what is known as Pitt's Wall, one of the first sea defences on the south side of that Yorkshire resort. He owned considerable land on the Belvedere estate at Bridlington, which was subsequently taken over by the Corporation. Mr. Pitt was twice married, and leaves two sons and two daughters.

We deeply regret to announce the death, on Saturday, May 20, of Mr. Arthur E. du Pasquier, M.I.E.E., at the age of 59 years, after a short illness. Mr. du Pasquier was manager of the publicity department at Metropolitan-Vickers Electrical Company, Limited, Trafford Park, having held this position since his return from South Africa in 1920. He had been the firm's representative in South Africa from the year 1915, and while there was elected President of the South African Institute of Electrical Engineers for the years 1919 and 1920. Previous to going to South Africa he had served the firm as sales engineer in the plant and export departments, and on the company's sales staff in the South Wales district. His Paper on "Electric Winding Engines—A Comparison of Systems and the Influence of Drum Profile on the Performance Obtained," presented to the South Wales Institute of Engineers in 1912, was for a long time regarded as a classic. He joined the company in October, 1902, and has thus seen nearly 31 years' service. Mr. du Pasquier is survived by his wife and son, who will have the deepest sympathy from all his friends in their sad bereavement.

Personal.

Mr. E. A. Atkins, M.I.Mech.E., of Liverpool, was elected President of the Institution of Welding Engineers at a meeting of the Council held at St. Ermin's Restaurant, London, S.W.1, on Wednesday, May 17.

Mr. Frederick T. Green, who was formerly with the North-Eastern Marine Engineering Company, Limited, Wallsend-on-Tyne, and Messrs. Smith's Dock Company, Limited, North Shields, has been appointed manager of the Southampton repair works of Messrs. J. Samuel White & Company, Limited.

Mr. A. Newlands, chief civil engineer of the L.M.S. Railway Company, has notified his intention to retire on July 1, 1933, after completing 41 years' railway service. He will be succeeded by Mr. W. K. Wallace, previously the engineer for the company's undertaking in Northern Ireland, who has for the past three years been chief stores superintendent.

Dr. H. J. Gough, Superintendent of the Engineering Department of the National Physical Laboratory, has been chosen to deliver the Eighth Edgar Marburg Lecture at the annual meeting of the American Society for Testing Materials, to be held in Chicago from June 26 to June 30. Dr. Gough will visit America with a group of scientists who have been invited by the Fair authorities and the A.A.A.S.

Mr. J. W. Eckford has been appointed sole representative for the Tyne district of Messrs. J. Parish & Company, proprietors of the Erith Loam Quarries. Mr. Eckford is the well-known honorary secretary for the Newcastle and District Branch of the Institute of British Foundrymen, and he is also an associate member of the Institute of Mechanical Engineers and a member of the Iron and Steel Institute.

Will.

Walker, John Cameron, J.P., Larbert, Stirlingshire, ironfounder, chairman of Dobbie Forbes & Company, Limited, Larbert Foundry £214,176

Company Reports.

Siemens Bros. & Company, Limited.—Final ordinary dividend of 4 per cent., making 6½ per cent. for 1932.

Richard Johnson & Nephew, Limited.—Net profit, £38,149; brought in, £24,138; dividend on the ordinary shares of 7 per cent.; carried forward, £30,787.

Manganese Bronze & Brass Company, Limited.—Net profit for 1932, £208, after placing £3,500 to depreciation reserve. This increases the balance brought forward to £3,396.

Glenfield & Kennedy, Limited.—Profit, £12,078; brought in, £62,397; final dividend of 2 per cent. on the ordinary shares, making 4 per cent. for the year; debit balances of two subsidiary companies written off, £7,018; carried forward, £47,582.

New Companies.

J. Parkes, Junr., Limited, 93, Wood Street, Willenhall, Staffs.—Capital, £2,000. Brass and general casters. Directors: J. H., and Mrs. E. M. Dainty (secretary).

Gilbert M. Scott & Company, Limited, 31, Irwell Chambers West, Fazakerley Street, Liverpool.—Capital £3,000. Iron and steel merchants. Directors: Mrs. F. E. Scott, R. T. Mann and F. D. Sharples.

Contracts Open.

Istanboul, June 15.—Cast-iron pipes, tanks, boilers, hydraulic winches, etc., for the Turkish State Railways. The Department of Overseas Trade. (Reference G.Y. 12,624.)

Johannesburg, July 3.—Five 4-ton electrically-driven portal jib cranes, for the South African Railways and Harbours. The Department of Overseas Trade. (Reference A.X. 11,795.)

Rochdale, May 27.—Cast-iron pipes and specials, for the Gas and Water Departments. The Town Clerk, Town Hall, Rochdale.

XUM

Raw Material Markets.

The home demand for iron and steel materials continues to expand slowly. Foundry-iron sellers report a steady business, with increasing activity in one or two centres. Business in semis is still rather slow, but there has been a marked contraction in purchases of Continental material, prices of which have risen considerably within the last few weeks. More work is being given out to the shipbuilding and heavy engineering industries, and prospects for the summer season are definitely more encouraging.

Scrap-iron prices, which recently declined, have shown a stronger tendency, following upon increased buying.

Pig-Iron.

MIDDLESBROUGH.—The local foundries, while not appreciably busier, are more willing to book forward, and the ironmasters have received a number of contracts extending to the end of June. They are still willing, however, to sell for immediate delivery. On the whole, the limited output is being absorbed. Export inquiries are broadening out since the negotiation of the Scandinavian trade agreements, and a number of small cargoes of iron have already been sent to the Baltic. Deliveries to Scotland are not quite as heavy as they were during April, but a steady business is still being done. The fixed zone prices for home deliveries still represent a preference to Scottish consumers, the delivered price of No. 3 Cleveland G.M.B. in Glasgow being 62s. 9d., whereas consumers in the Middlesbrough area are paying 62s. 6d. and elsewhere on the North-East Coast 64s. 6d. To these prices 2s. 6d. per ton is added where No. 1 Cleveland foundry iron is required, No. 4 foundry and No. 4 forge being offered at 1s. per ton less than No. 3 G.M.B.

A heavier demand has been witnessed for East Coast hematite. The nominal quotations are unchanged at 59s. per ton f.o.t. or f.o.b. for mixed numbers and 59s. 6d. for No. 1 quality, but there is now little selling below this level by the merchants. Hints are being made by the makers of increased quotations in this market.

LANCASHIRE.—The outlook in this area is distinctly brighter. Several Midlands ironmasters are doing increased business with Lancashire founders, who are now more willing to enter into forward contracts. Disappointment is, however, felt that the conditions in the textile-machinery industry do not improve. For delivery to consumers in the Manchester price zone, Derbyshire and Staffordshire iron is quoted on the basis of 67s. per ton for No. 3, with North-East Coast foundry also at 67s., Northamptonshire at 65s. 6d., Derbyshire forge at 62s., Scottish No. 3 at about 82s., and East and West Coast hematite at 75s. 6d. and 80s. 6d., respectively.

MIDLANDS.—Conditions are appreciably better in the consuming industries in this area, particularly in the light-castings section. General-castings makers, however, are still very short of work. Prices of foundry iron are unaltered, the minimum zone rates applying to Birmingham and Black Country stations, these being 62s. 6d. for Northamptonshire No. 3 and 66s. for Derbyshire, North Staffordshire and Lincolnshire No. 3. Forge iron for foundry use is 4s. below the respective No. 3 price. There continues to be a little Cleveland No. 3 coming into South Staffordshire at 66s. delivered. Foreign foundry iron is of no interest. In connection with hematite there has been a fair amount of buying for forward delivery, West Coast hematite being at the controlled level of 84s. 6d., with Welsh and East Coast uncontrolled at prices ranging from 74s. 6d. to 77s. 6d. per ton. There continues to be an improved demand for medium- and low-phosphorus foundry iron, quotations varying from 70s. up to 85s., Scottish No. 3 being offered at between 83s. and 85s. per ton.

SCOTLAND.—Buying continues to be only for day-to-day requirements, owing to the lack of work at the foundries, whose prospects show little sign of betterment at the moment. The official minimum price of 65s. f.o.t. furnaces for No. 3 Scottish foundry iron remains in force, with an extra of 2s. 6d. for No. 1 foundry. Shipments of Middlesbrough iron are light. No. 3 Middlesbrough is quoted at 59s. 9d. Falkirk area and 62s. 9d. Glasgow area, with No. 4 foundry at 1s. less. Midland iron is offered at 2s. 3d. below these figures, but little is coming forward.

Coke.

Conditions in this market show no change for the better. The producers would be prepared to book well forward at the current rates, which have been unchanged for some time, but consumers show little interest. Quotations for Durham coke at Birmingham remain at 36s. 6d. to 38s. 6d., other grades being obtainable at down to 35s. Quotations for Welsh coke vary from 30s. up to 40s. per ton, delivered Birmingham and district.

Steel.

Steady conditions rule in the steel markets, and there would seem to be a gradual expansion in general business on home account. Export trade, however, is still handicapped by artificial restrictions, and, in the case of a number of markets, by the difficulty of securing remittances. The demand for semi-finished steel is still restricted by the reluctance of consumers to buy forward, although this attitude is less noticeable than earlier in the year, when it was occasionally possible to obtain Continental material at competitive prices. Practically no orders have been placed by British consumers with Continental producers for several weeks, and there has been an increasing volume of business moving to the home works. In the finished-steel department conditions are more active than for some time past, and in some descriptions of steel there is a tendency for the home prices to rise, in the absence of Continental competition. Export business has been slow, but shows signs of broadening.

Scrap.

Conditions in the Cleveland scrap-iron market have shown a slight recovery, several consumers having been in the market for supplies. Ordinary heavy cast iron is at about 37s. 6d. per ton, machinery quality at 40s. and light cast iron at 34s. There is still a steady demand for cast-iron scrap in the Midlands, where machinery metal is quoted at 47s. 6d., heavy pipe and plate at 45s., and clean light at 38s. 6d., delivered. There has been a rather poor inquiry in the Scottish market for machinery metal, in suitable sizes for foundry cupolas, which is at 48s. 6d. to 49s. Ordinary cast iron to the same specification is at 45s. to 46s., with light cast at 37s. 6d. per ton.

Metals.

Copper.—Quotations on the London Metal Exchange rose considerably last week, £36 per ton, three months, being paid for standard metal on Thursday. Since then, however, prices have fallen away slightly owing to the lack of support from consumers in Europe. British cablemakers and wire-drawers' purchases of copper have declined seriously during the past few months, owing to the completion of work on the national electricity "grid" system. The majority of other consumers are reported to be well covered for the moment. Producers in America are said to be considering a general curtailment of output to 10 per cent. of capacity and the closing of a number of uneconomic properties, and it is probable that action on these lines will be taken.

The week's prices have been as follow :—

Cash.—Thursday, £35 2s. 6d. to £35 3s. 9d.; Friday, £34 12s. 6d. to £34 13s. 9d.; Monday, £34 5s. to £34 6s. 3d.; Tuesday, £33 12s. 6d. to £33 13s. 9d.; Wednesday, £34 15s. to £34 16s. 3d.

Three Months.—Thursday, £35 6s. 3d. to £35 7s. 6d.; Friday, £34 17s. 6d. to £34 18s. 9d.; Monday, £34 10s. to £34 11s. 3d.; Tuesday, £33 16s. 3d. to £33 17s. 6d.; Wednesday, £35 to £35 1s. 3d.

Tin.—Prices have shown an irregular course, but are maintained at the higher level of the last week or so. Moderate buying by European consumers has been seen, but the American demand is receding slightly. The shortage of Straits tin continues to excite comment, and it is urged that the F.M.S. mines be granted an increased output quota. The fact that, owing to the restriction of supplies, a premium of £20 and more is being asked for this grade, is losing, and has lost, a good many customers for the Straits brands. A new quota comes into force on July 1, which will mean an additional reduction of 1,000 tons in the monthly world supplies, and in the same month the International Pool will begin to release its stocks.

Daily quotations :—

Cash.—Thursday, £190 10s. to £190 15s.; Friday, £189 10s. to £189 12s. 6d.; Monday, £186 15s. to £187; Tuesday, £186 2s. 6d. to £186 5s.; Wednesday, £190 7s. 6d. to £190 10s.

Three Months.—Thursday, £190 17s. 6d. to £191; Friday, £189 12s. 6d. to £189 15s.; Monday, £187 5s. to £187 10s.; Tuesday, £186 10s. to £186 12s. 6d.; Wednesday, £190 12s. 6d. to £190 15s.

Spelter.—This market maintains a fairly firm tone. Although there has been no material increase of activity in the consuming industries, prospects are generally stated to have improved. The London market has witnessed heavy liquidation from one quarter, but all metal offered was speedily absorbed, thus indicating the healthy state of the market. The forthcoming meetings of the members of the International Zinc Cartel, to discuss the prolongation of the Cartel beyond July 1, 1933, are exciting considerable attention, as the producers are far from unanimous on the question of output restrictions.

Price fluctuations :—

Ordinary. — Thursday, £15 15s.; Friday, £15 13s. 9d.; Monday, £15 7s. 6d.; Tuesday, £15 7s. 6d.; Wednesday, £15 15s.

Lead.—The market has maintained a fairly steady appearance. Active conditions continue in the pipe and sheet trade in this country, and battery makers are benefiting from the increasing demand for motor-cars. This improvement has, however, been offset by the poor demand from the cable-makers, who are finding themselves short of work now that many of the Central Electricity Board contracts have been completed.

Daily market prices :—

Soft Foreign (Prompt).—Thursday, £12 7s. 6d.; Friday, £12 6s. 3d.; Monday, £12 1s. 3d.; Tuesday, £11 17s. 6d.; Wednesday, £12 1s. 3d.

Book Review.

The Metallography of Iron and Steel, by C. Hubert Plant. Published by Sir Isaac Pitman & Sons, Limited, Parker Street, Kingsway, W.C.2. Price 12s. 6d. net.

This book is written "for the student, the manager and the practical man," and is an attempt to explain the theoretical metallurgy of iron and steel from its elementary to its most advanced stages. To claim this in a volume of merely 200 pages is indeed ambitious, particularly as it is obvious from a glance at the book that the author has insufficient knowledge of the materials about which he has written. This book contains mistakes in elementary chemistry, such as the description of a diamond as carbon in the amorphous condition, and reference to "liquid carbon," as well as serious metallurgical errors. For instance, semi-steel is described as a material "with a carbon content not greatly above 1.7 per cent.," and also as "a cast iron of a very questionable constitution." It is also interesting to learn that "white-heart malleable cast iron is annealed at 750 deg. C.," while for black-heart malleable "a considerably higher temperature is necessary."

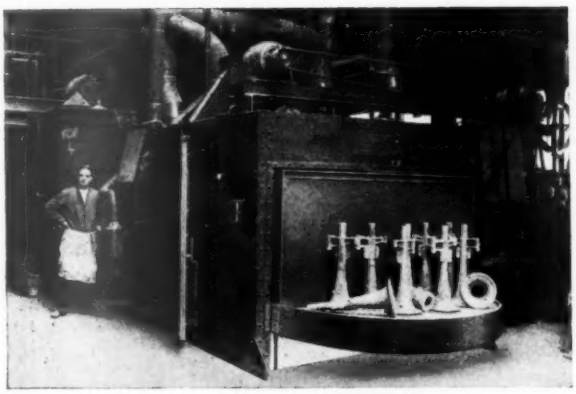
The author appears to have dabbled in the theoretical aspect of his subject without appreciating the practical significance, and such procedure is very dangerous. The bibliography given at the end of the book is a disconnected assortment of references to the technical Press and is not in any way complete. The author confuses austenitic cast iron with hardened and tempered cast iron of lower-alloy content in a manner which must bewilder the student.

The book is misleading and inaccurate in many particulars. It is a marked contrast to note that the dust cover provided with the book carries advertisements for books dealing with cast iron, bronze and metallographic technique, which are recognised authoritative works on their respective subjects.

F. K. N.

XUM

TILGHMAN'S—The Originators of the SAND BLAST PROCESS



The illustrations herewith are two views of a Sand Blast Room with revolving table adapted to meet customer's requirements. This type of plant is capable of dealing with a continuous production.

TILGHMAN'S

PATENT SAND BLAST Co., Ltd., BROADHEATH, Nr. MANCHESTER.

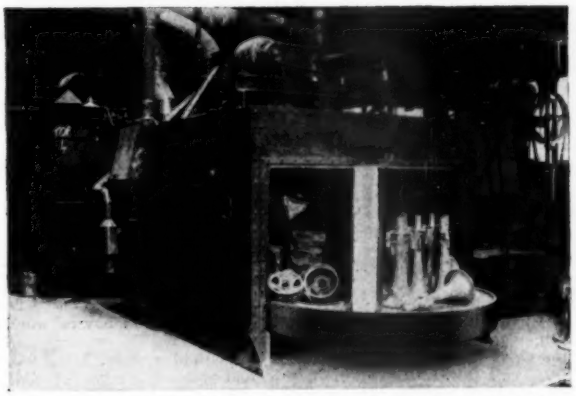
London Office - 17, Grosvenor Gardens, S.W.1.

19631

MAKE SAND BLAST PLANTS TO ANY DESIGN NO MATTER WHAT YOUR REQUIREMENTS MAY BE.

TILGHMAN'S ARE PREPARED TO ASSIST YOU IN ANY PROBLEM IN SAND BLASTING OR ITS POSSIBLE APPLICATION TO ANY OF YOUR MANUFACTURING PROCESSES.

Their unrivalled experience is at your disposal —their product is ENTIRELY BRITISH.



Photographs reproduced by courtesy of The Austin Motor Co., Ltd.

WARNER C.P.R.
CYLINDER
PIG IR
"The brand of proved rel
Supplied to specifications covering a wide range of requirements and employed by the leading Railway Co's Roll Makers and Engineering Founders.
WARNER &
CARGO FLEET
MIDDLESBROUGH

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	34	15	0
Three months	35	0	0
Electrolytic	39	0	0
Tough	37	0	0
Best selected	37	10	0
Sheets	65	0	0
India	48	10	0
Wire bars	39	15	0
Do., June	39	12	6
Do., July	39	10	0
Ingot bars	39	15	0
H.C. wire rods	41	10	0
Off. av. cash, April	29	12	5⅛
Do., 3 mths., April	29	16	6¾
Do., Sttlmnt., April	29	12	9½
Do., Electro, April	33	19	4½
Do., B.S., April	32	14	4½
Do., wire bars, April	34	5	1⅝
Solid drawn tubes			10d.
Brazed tubes			10d.
Wire			7d.

BRASS.

Solid drawn tubes	9d.
Brazed tubes	11d.
Rods, drawn	8½d.
Rods, extd. or rlld.	4¼d.
Sheets to 10 w.g.	7¼d.
Wire	7¾d.
Rolled metal	7¾d.
Yellow metal rods	4½d.
Do. 4 × 4 Squares	5½d.
Do. 4 × 3 Sheets	5¼d.

TIN.

	£	s.	d.
Standard cash	190	7	6
Three months	190	12	6
English	191	15	0
Bars	193	0	0
Straits	207	10	0
Australian	200	0	0
Eastern	207	10	0
Banca (nom.)	206	0	0
Off. av. cash, April	158	0	4⅛
Do., 3 mths., April	158	15	1⅝
Do., Sttlmt., April	158	0	3⅛

SPELTER.

	£	s.	d.
Ordinary	15	15	0
Remelted	15	10	0
Hard	13	5	0
Electro 99.9	17	15	0
English	16	10	0
India	14	10	0
Zinc dust	19	0	0
Zinc ashes	2	5	0
Off. aver., April	15	1	7⅛
Aver. spot, April	14	19	0⅓

LEAD.

	£	s.	d.
Soft foreign ppt.	12	1	3
Empire	12	5	0
English	13	10	0
Off. average, April	10	19	11⅓
Average spot, April	10	17	5⅓

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	24	10	0
Do., V.M. ex-whse.	23	5	0
Rods	28	0	0
Boiler plates		—	
Battery plates		—	

ANTIMONY.

	£	s.	d.	£	s.	d.
English	35	0	0 to 40	0	0	
Chinese				26	10	0
Crude				—		

QUICKSILVER.

	£	s.	d.	£	s.	d.
Quicksilver	8	10	0 to 9	10	0	

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro silicon—	
25%	—
45/50%	—
75%	—
Ferro-vanadium—	
35/50%	12/8 lb. Va.
Ferro-molybdenum—	
70/75% carbon-free of Mo.	6/3 per lb.
Ferro-titanium—	
23/25% carbon-free	10d. lb.
Ferro-phosphorus, 20/25%	£17 17 6
Ferro-tungsten—	
80/85%	1/6 lb.
Tungsten metal powder—	
98/99%	1/9 lb.
Ferro-chrome—	
2/4% car.	—
4/6% car.	—
6/8% car.	—
8/10% car.	—
Ferro-chrome—	
Max. 2% car.	—
Max. 1% car.	—
Max. 0.70% car.	—
70% carbon-free	—
Nickel—99.5/100%	£230
"F" nickel shot	£202 10 0
Ferro-cobalt	5/9 lb.
Aluminium 98/99%	£100 0 0
Metallic chromium—	
96/98%	2/8 lb.
Ferro-manganese (net)—	
76/80% loose	£10 15 0 to £11 5 0
76/80% packed	£11 15 0 to £12 5 0
76/80% export (nom.)	£9 15 0
Metallic manganese—	
94/96% carbon-free	1/4 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	2s. 0d.
Finished bars, 18% tungsten	2s. 9d.

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to $\frac{3}{16}$ in.	1/– lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅛ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/– lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP.

	£	s.	d.	£	s.	d.
South Wales—						
Heavy steel	2	4	0 to	2	5	0
Bundled steel and shrngs.	1	17	6 to	2	4	0
Mixed iron and steel	2	0	0 to	2	1	6
Heavy cast iron	2	3	6 to	2	4	0
Good machinery	2	8	0 to	2	10	0
Cleveland—						
Heavy steel				1	17	6
Steel turnings				1	11	6
Cast-iron borings				1	2	0
Heavy forge				2	10	0
W.I. piling scrap				2	0	0
Cast-iron scrap	1	17	6 to	2	0	0
Midlands—						
Light cast-iron scrap	1	18	6 to	2	0	0
Heavy wrought iron				2	5	0
Steel turnings, f.o.r.				1	4	6
Scotland—						
Heavy steel				1	17	6
Ordinary cast iron	2	5	0 to	2	6	0
Engineers' turnings	1	11	6 to	1	12	6
Cast-iron borings				1	12	6
Wrought-iron piling				2	1	3
Heavy machinery	2	8	6 to	2	9	0

London—Merchants' buying prices, delivered yard.

	£	s.	d.
Copper (clean)	26	0	0
Brass	17	0	0
Lead (less usual draft)	11	0	0
Tea lead	9	10	0
Zinc	9	10	0
New aluminium cuttings	74	0	0
Braziery copper	22	0	0
Gunmetal	21	0	0
Hollow pewter	115	0	0
Shaped black pewter	85	0	0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast (d/d Tees-side area)—	
Foundry No. 1	65/–
Foundry No. 3	62/6
,, at Falkirk	59/9
,, at Glasgow	62/9
Foundry No. 4	61/6
Forge No. 4	61/6
Hematite No. 1, f.o.t.	59/6
Hematite M/Nos., f.o.t.	59/–
N.W. Coast—	
Hem. M/Nos. d/d Glas.	68/6
,, d/d Birm.	84/6
Malleable iron d/d Birm.	115/–
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	62/–
,, No. 3 fdry.	66/–
Northants forge	58/6
,, fdry. No. 3	62/6
,, fdry. No. 1	65/6
Derbyshire forge	62/–
,, fdry. No. 3	66/–
,, fdry. No. 1	69/–
Scotland—	
Foundry No. 1	67/6
,, No. 3	65/–
Hem. M/Nos. d/d	66/–
Sheffield (d/d district)—	
Derby forge	59/6
,, fdry. No. 3	63/6
Lincs forge	59/6
,, fdry. No. 3	63/6
E.C. hematite	73/6
W.C. hematite	83/6
Lancashire (d/d eq. Man.)—	
Derby fdry. No. 3	67/–
Staffs fdry. No. 3	67/–
Northants fdry. No. 3	65/6
Cleveland fdry. No. 3	67/–
Dalzell, No. 3 (special)	102/6 to 105/–
Glengarnock, No. 3	82/–
Clyde, No. 3	82/–
Monkland, No. 3	82/–
Summerlee, No. 3	82/–
Eglinton, No. 3	82/–
Gartsherrie, No. 3	82/–
Shotts, No. 3	82/–

FINISHED IRON AND STEEL.

Usual district deliveries for iron; delivered consumer's station for steel.

Iron—	£	s.	d.	£	s.	d.
Bars (cr.)	9	0	0 to	9	15	0
Nut and bolt iron	6	15	0 to	7	10	0
Hoops	10	10	0 to	12	0	0
Marked bars (Staffs) f.o.t.				12	0	0
Gas strip	10	10	0 to	12	0	0
Bolts and nuts, ¾ in. × 4 in.				12	17	6
Steel—						
Plates, ship, etc.	8	15	0 to	8	17	6
Boiler plts.				8	5	0
Chequer plts.				10	7	6
Angles				8	7	6
Tees				9	7	6
Joists				8	15	0
Rounds and squares, 3 in. to 5½ in.				9	7	6
Rounds under 3 in. to ⅜ in. (Untested)	6	15	0 & up.			
Flats—8 in. wide and over				8	12	6
,, under 8 in. and over 5 in.				8	17	6
Rails, heavy	8	5	0 to	8	10	0
Fishplates				12	0	0
Hoops (Staffs)	9	10	0 & up.			
Black sheets, 24g. (10-t. lots)				9	15	0
Galv. cor. shts.	,,			12	0	0
Galv. flat shts.	,,			12	10	0
Galv. fencing wire, 8g. plain				14	0	0
Billets, soft	5	0	0 to	5	7	6
Billets, hard	6	12	6 to	7	2	6
Sheet bars	4	15	0 to	5	2	6
Tin bars				4	15	0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	11d.
Sheet to 10 w.g.	12d.
Wire	12½d.
Rods	11d.
Tubes	15½d.
Castings	13d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7½
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
to 10g.	1/4½ to 1/11½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	15.34
No. 2 foundry, Valley	14.50
No. 2 foundry, Birm.	12.00
Basic	15.89
Bessemer	16.89
Malleable	16.39
Grey forge	16.39
Ferro-mang. 80%, seaboard	68.00
O.-h. rails, h'y, at mill	40.00
Billets	26.00
Sheet bars	26.00
Wire rods	35.00
	Cents.
Iron bars, Phila.	1.86
Steel bars	1.60
Tank plates	1.60
Beams, etc.	1.60
Skelp, grooved steel	1.60
Steel hoops	1.55
Sheets, black, No. 24	2.00
Sheets, galv., No. 24	2.70
Wire nails	1.85
Plain wire	2.10
Barbed wire, galv.	2.35
Tinplates, 100-lb. box	$4.25

COKE (at ovens).

Welsh foundry	20/– to 22/6
,, furnace	15/– to 16/–
Durham and Northumberland—	
,, foundry	21/– to 25/–
,, furnace	13/3
Midlands, foundry	—
,, furnace	—

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 per box		16/6 to 16/9
,,	28×20	,,	33/– to 33/6
,,	20×10	,,	23/9
,,	18¾×14	,,	17/1½
C.W.	20×14	,,	15/3
,,	28×20	,,	31/–
,,	20×10	,,	—
,,	18¾×14	,,	

SWEDISH CHARCOAL IRON & STEEL.

	£	s.	d.	£	s.	d.
Pig-iron	6	0	0 to	7	0	0
Bars-hammered, basis	16	10	0 to	17	0	0
Bars and nail-rods, rolled, basis	15	17	6 to	16	5	0
Blooms	10	0	0 to	12	0	0
Keg steel	32	0	0 to	33	0	0
Faggot steel	18	0	0 to	23	0	0
Bars and rods dead soft, st'l	10	0	0 to	12	0	0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 18.16 to £1.]

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£ s. d.	
May	18 ..	35 2 6 inc.	1/3
,,	19 ..	34 12 6 dec.	10/–
,,	22 ..	34 5 0 ,,	7/6
,,	23 ..	33 12 6 ,,	12/6
,,	24 ..	34 15 0 inc.	22/6

Electrolytic Copper.

		£ s. d.	
May	18 ..	39 10 0	No change
,,	19 ..	39 5 0 dec.	5/–
,,	22 ..	39 5 0	No change
,,	23 ..	38 10 0 dec.	15/–
,,	24 ..	39 0 0 inc.	10/–

Standard Tin (cash).

		£ s. d.	
May	18 ..	190 10 0 inc.	65/–
,,	19 ..	189 10 0 dec.	20/–
,,	22 ..	186 15 0 ,,	50/–
,,	23 ..	186 2 6 ,,	12/6
,,	24 ..	190 7 6 inc.	85/–

Tin (English ingots).

		£ s. d.	
May	18 ..	192 0 0 inc.	70/–
,,	19 ..	190 15 0 dec.	25/–
,,	22 ..	188 5 0 ,,	50/–
,,	23 ..	187 10 0 ,,	15/–
,,	24 ..	191 15 0 inc.	85/–

Spelter (ordinary).

		£ s. d.	
May	18 ..	15 15 0 inc.	1/3
,,	19 ..	15 13 9 dec.	1/3
,,	22 ..	15 7 6 ,,	6/3
,,	23 ..	15 7 6	No change
,,	24 ..	15 15 0 inc.	7/6

Spelter (Electro, 99.9 per cent.).

		£ s. d.	
May	18 ..	17 15 0	No change
,,	19 ..	17 15 0 ,,	,,
,,	22 ..	17 12 6 dec.	2/6
,,	23 ..	17 12 6	No change
,,	24 ..	17 15 0 inc.	2/6

Zinc Sheets (English).

		£ s. d.	
May	18 ..	24 10 0 inc.	10/–
,,	19 ..	24 10 0	No change
,,	22 ..	24 10 0 ,,	,,
,,	23 ..	24 10 0 ,,	,,
,,	24 ..	24 10 0 ,,	,,

Lead (English).

		£ s. d.	
May	18 ..	13 15 0 inc.	5/–
,,	19 ..	13 15 0	No change
,,	22 ..	13 10 0 dec.	5/–
,,	23 ..	13 5 0 ,,	5/–
,,	24 ..	13 10 0 inc.	5/–

AVERAGE MONTHLY PRICES OF MARKED BARS (SOUTH STAFFS).

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1899	8 0 0	8 0 0	8 0 0	8 0 0	8 10 0	8 10 0	9 0 0	9 0 0	9 10 0	10 0 0	10 0 0	10 0 0	8 3 4
1900	11 0 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 10 0	11 5 10
1901	9 10 0	9 10 0	9 10 0	9 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 16 8
1902	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 5 0	8 5 0	8 5 0	8 5 0	8 5 0	8 5 0	8 7 6
1903	8 5 0	8 5 0	8 5 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 8 9
1904	8 10 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 10
1905	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 10 0	8 10 0	8 1 8
1906	8 10 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	8 10 0	8 10 0	8 10 0	8 10 0	9 0 0	8 15 10
1907	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0
1908	9 0 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 5 10
1909	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0
1910	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0
1911	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0
1912	8 10 0	8 10 0	8 10 0	8 15 0	9 0 0	9 0 0	9 0 0	9 8 0	9 10 0	9 10 0	9 10 0	9 15 0	9 1 6
1913	10 0 0	10 0 0	10 0 0	10 0 0	10 0 0	10 0 0	10 0 0	9 10 0	9 10 0	9 4 0	9 0 0	9 0 0	9 13 8
1914	8 12 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	8 14 4
1915	9 0 0	9 0 0	9 3 0	10 2 0	10 15 0	11 10 0	11 0 0	12 0 0	12 0 0	12 7 6	12 10 0	13 10 0	11 5 9
1916	13 10 0	13 10 0	14 13 0	15 0 0	15 0 0	15 0 0	15 0 0	15 10 0	15 10 0	15 0 0	15 10 0	15 0 0	14 18 7
1917	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0
1918	15 12 6	16 0 0	16 0 0	16 0 0	16 0 0	16 0 0	16 0 0	16 0 0	16 0 0	17 0 0	17 0 0	17 0 0	16 6 3
1919	18 0 0	18 10 0	20 0 0	20 0 0	23 0 0	23 0 0	23 0 0	24 12 0	25 0 0	25 0 0	25 0 0	25 5 0	22 10 7
1920	26 17 6	27 0 0	28 0 0	30 5 0	30 10 0	33 10 0	33 10 0	33 10 0	33 10 0	33 10 0	33 10 0	33 10 0	31 10 2
1921	31 10 0	30 3 4	27 10 0	27 10 0	27 10 0	24 15 0	21 0 0	20 0 0	20 0 0	17 10 0	17 0 0	16 0 0	23 7 4
1922	16 0 0	14 17 6	14 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 18 1½
1923	13 10 0	13 10 0	13 16 0	14 7 6	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 5 3½
1924	14 10 0	14 10 0	14 10 0	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	14 17 6	14 17 3½
1925	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 0 0	14 13 4
1926	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	14 0 0	*	14 10 0	14 0 10
1927	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	13 10 0	13 10 0	13 10 0	13 0 0	13 0 0	12 18 0	13 15 8
1928	12 10 0	12 10 0	12 10 0	12 2 6	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 2 8½
1929	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 7 6	12 10 0	12 10 0	12 2 3½
1930	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0
1931	12 10 0	12 10 0	12 10 0	12 8 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 3 2
1932	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0	12 0 0
1933	12 0 0	12 0 0	12 0 0	12 0 0	—	—	—	—	—	—	—	—	—

* No quotation available.

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